DOCTOR OF ENGINEERING (ENGD)

The Gameful Museum: Authenticity and Entertainment in the Digital Age

De Angeli, Daniela

Award date:
2018

Awarding institution:
University of Bath

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Daniela De Angeli

A thesis submitted for the degree of Doctor of Engineering
University of Bath
Centre for Digital Entertainment
January 2018

“Play is an essential component of all human culture”

Johan Huizinga, Homo Ludens, 1938

Acknowledgements

I would like to thank everyone who has helped me throughout my research. I am indebted to you all and owe you my eternal gratitude.

First of all, I wish to thank my supervisor, Eamonn O'Neill. I thank you for always supporting me and my 'weird' ideas. Our meetings were not only educational but also very enjoyable.

Furthermore, I thank all the members of the Department of Computer Science at the University of Bath. A special thanks goes to Luca Benedetti, Dmitry Kit and Ryan Kelly for their precious suggestions. I also thank everybody in my office because they made my work easier and very pleasant.

I wish to thank all those who participated in my studies and those who made those studies possible. In particular, I would like to thank all the volunteers who helped during the different editions of GameTale: Ioannis Benardis, Christina Keating, Zack Lyons, Bingjie Yu, Lauren Ferro, José Serra, Camille Paoletti, Andrea Aler Tubella, Daniel J. Finnegan, Horia Bogdan, and Luca Benedetti. I would also like to thank Xindan Wang for helping with the investigation of the augmented reality sandbox.

A very special thanks goes to my mother, Patrizia Pinaffo, for her constant encouragement and the economic support she has provided throughout my studies. I would not be where I am today without you.

Thank you *Manilaaaæ* for being my home away from home.

Finally, I wish to thank *The Playmates* for bringing joy, serenity and games into my life.

Abstract

Digital technologies are part of our every day lives, affecting how people communicate and perceive the world, and pressuring museums into rethinking their exhibitions in order to stay relevant and drive visits. Visitors increasingly expect experiences that are not only educational and authentic, but also entertaining and relevant for them. However, museums are struggling to balance their traditional rigor with the requirements of a changing society and are increasingly considering participatory activities as a solution to better understand visitors and design experiences that are more relevant and engaging for the public.

Among participatory practices, games are well-established and have been successfully used both as a co-design technique and as a method to collect data from and about players. Moreover, games are both engaging and relevant; they have a key role in contemporary society as they are played by an increasing number of people all over the world. Thus, games are gaining reach in entertainment, popular culture, and as an academic field of study. But despite their growing popularity and their potential as a participatory method, games are still used in museums for educational purposes rather than as a design and research method.

The core of this thesis is the research of game-based activities - or **gamefulness** - as a tool to **promote authentic and entertaining experiences in museums**. In order to address this main research topic, I used a combination of methods, building upon theoretical work and a series of empirical studies. First, I developed an understanding of authenticity and entertainment, outlining their relevance in contemporary museums. Then, I planned a series of activities that involved playing and making games with both museum professionals and the general public. Through those game-based studies I investigated how to collect data to support the design of new interactive experiences.

Thus, this thesis main contribution is Research through Games, a *research method that employs game creation and game play to inform future user experiences that are both meaningful and entertaining*. A secondary contribution is the implementation and validation of a method to measure visitors' perception of authenticity and entertainment with interactive museum experiences. Since the perception of authenticity and entertainment is dictated by our personal feelings, I focused on accessing affective states. However, human feelings are particularly difficult to evaluate and traditional means are often intrusive or ineffective. Instead, our method is engaging, lightweight, and relies on graphical symbols to communicate emotions (a.k.a. Emoji).

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List of Abbreviations

1001DT – 1001 Dyrham Tales

AR - Augmented Reality

BRLSI - Bath Royal Literary and Scientific Institution

CI - Confidence Interval

DVB - Digital Visitors Book

GJ - Game Jam

GJJ - Global Game Jam

GT - Game Tale

HCI – Human Computer Interaction

InK - Interactive Kiosk

NT - National Trust

RtG - Research through Games

TADT - Tell-A-Dyrham-Tale

VR - Virtual Reality

Chapter 1

Introduction

The rapid development of digital technologies is affecting the way people live, communicate and pass their leisure time. Contemporary museums are competing for people's attention with a variety of digital entertainment options. Visitors are looking for experiences that are not only educative and authentic, but also entertaining. Thus, museums are pressured into designing experiences that are more interactive and digital. However, museums are struggling to balance their traditional rigour and the need for authenticity with the requirements of a changing society. Most museums are still faithful to the traditional object-centered approach that leads to a passive experience, which is not what most visitors wish for.

Digital technologies offer new opportunities to engage the public with active and interactive experiences. In particular, digital games are gaining reach in entertainment, popular culture, and as an academic field of study (Seaborn and Fels, 2015). Despite their growing popularity, the use of games in museums is still very limited. Museums have been using games mainly for educational purposes but games can be much more than an educational tool. For example, games and game affordances are used as a tool to motivate users and co-design new products. Moreover, playing and making game can provide data from and about players. Hence, I investigated how game-based activities can provide information about visitors' interests and needs, and how this can inform the design of new museums exhibitions that are not only educative but also entertaining and relevant. I defined game-like activities as gameful (Chapter 1.1.4).

Thus, I researched whether gamefulness can promote authentic and entertaining experiences in museums. I tried to answer this research question through steps. First, I searched relevant literature review and collect empirical data to understand how digital technologies are affecting museum (Chapter 1) and how visitors perceive authenticity and entertainment (Chapter 2). Then, I involved museum professionals (chapter 3) and general public (chapter 4) in a series of gameful activities to support the design of authentic and entertaining experiences. Finally, I investigate how to evaluate authentic and entertaining experiences (chapter 5).

1.1 Background

Technology often drives **changes in society**, influencing how we live,

communicate, learn, and in general how we perceive the world (Bryce, 2001; Greenfield, 2014; Siemens, 2014). For example, today we use social networking, gaming and search engines on a daily basis (Greenfield, 2014). We can order food and clothes online and get them delivered at home. We can browse for information online, without physically visiting a library or a museum. Technological leisure such as playing video games or gaming fulfils our need for relaxation, social interaction, escape and stimulation. Technology is rewiring our brains and giving us the power of multitasking and ubiquity (Bryce, 2001). Our lives are moving at such a fast pace that we rapidly move from one task to another, from one topic to another (Siemens, 2014). Technology offers us so many options for our entertainment (Greenfield, 2014) that our knowledge and our interests are in continuous evolution (Siemens, 2014).

1.1.1 The Effects of Digital Technologies in Museum

Recent advances in digital **technologies** (e.g. Augmented and Virtual Reality) are enabling a different kind of engagement, more interactive, pressuring museums into redesigning their exhibits to share knowledge through enjoyable, entertaining experiences in order to drive visits (Tallon and Walker, 2008) and support other goals such as education and conservation (Murphy, 2007). Museums are introducing technologies in order to personalize experiences (Tallon and Walker, 2008), connect with the public and attract visits (Maye et al., 2014).

But while contemporary museums have the potential and the mission to present knowledge in authoritative yet enjoyable ways (Murphy, 2007), they often **struggle** to balance their traditional rigour with the requirements of a changing society (Falk and Dierking, 2000). For example, it is not completely clear whether virtual experiences can positively support the experience or instead distract from the artefacts and the real experience (De Angeli and O'Neill, 2015; Falk and Dierking, 2000). Contemporary museums are often worried about focusing too much on entertaining, losing their perceived authority and becoming mere entertainment parks (Wolf et al., 2007). At the same time, museums need to maintain their relevance in a changing society as their mission is not only to preserve knowledge but also to share it (Murphy, 2007).

Museums have always interpreted knowledge, create meaning and share it through their exhibitions (Bedford, 2001; Hooper-Greenhill, 1999; Johnsson, 2006): "Storytelling is at the heart of what many museums do. They use stories to breathe life into their collections, making connections with different times, often different continents, cultures and beliefs, capturing a range of emotions" (Johnsson, 2006, p. 2). Thus, museums are not just the "keeper of artefacts" but also of *stories* (Beale and Villeneuve, 2011). However, traditionally narration was focused on objects (Wyman et al., 2011). Curators were focused on preserving and presenting the **'authentic' object** detached from *human intent* (Evans et al., 2002), representing the singular authoritative voice of the museums (Tallon and Walker, 2008). This approach leads to a very classical exhibit that generally limits visitors' interaction to

merely passive observation. But according to Nina Simon, from the Santa Cruz Museum of Art & History (MAH): *"Most museums are set up for a passive, individual experience and that's not how most people choose to spend their recreational time"* (Simon, 2010).

Museums have always conveyed knowledge through the display of physical objects and visitors trusted museums to choose which objects to display (Chamberlain, 2011), but now the simple display of facts and objects is no longer enough to attract and engage visitors. Visitors still expect museums to deliver authentic content, but they also expect a more engaging experience and a deeper connection with the museum and its offering (Hargrove, 2003; Sanders et al., 2010): *"Authenticity often comes up as a visitor concern in evaluation - they trust us to deliver it and we must recognise the unwritten contract between us. Of course our audiences also come to us for entertainment …"* (Chamberlain, 2011). Visitors are increasingly asking museums for a more interactive experience than the traditional visit, to be active authors rather than just passive observers (Tallon and Walker, 2008). Thus, museums are moving away from the simple display of objects, **shifting from an object-centered approach to a visitor focused** one where it is increasingly essential to understand visitors and how they interact with the artefacts in order to design narratives that are more engaging and meaningful (Galani, A., Maxwell, D., Mazel, A., & Sharpe, 2011; Hansen et al., 2012; Simon, 2016). Museum are starting to embrace the idea that there is "no single authentic voice" but multiple experiences (Evans et al., 2002, p. 53) as visitors themselves create meaning based on their personal experience and background.

Traditionally museums have analysed visitors' experience and behaviour by focusing primarily on observational research (Lankes et al., 2015) or organizing co-design workshops involving mostly experts, where curators and educators were given specific topics or visitor personas (e.g. a teenager) for which to design (Roussou et al., 2015). In the first case, museums look at what people do and use, instead of what people need, do and make (Lankes et al., 2015). In the second approach, museums designed for the users, but not with the users (Lankes et al., 2015). However, the design of new museum experiences involves different stakeholders (e.g. educators, curators, and local communities), each with their own **values and needs**: "What is relevant to one person can be irrelevant to their neighbor. (…) What is relevant today may be irrelevant tomorrow" (Simon, 2016, p. 41). It is a complex issue that can effectively be addressed with design-oriented research (Zimmerman et al., 2010), where visitors are involved directly as participants in the design process (Simon, 2016).

Therefore, museums are increasingly considering **participatory practices** such as collaborative workshops (Roussou et al., 2015) as a method to understand visitors' needs, requirements and expectations. By involving visitors directly in the design process, the museum allow people to create their own meaning (Chatham et al., 2013), fostering engagement (both individual and social) (Deen et al., 2014), and involvement (Simon, 2016). Through co-participation, visitors can contribute, discuss what they are interested in, and connect with collections. Through co-participation,

museums can develop new engaging experiences, fulfill their need to demonstrate their value, reconnect with their public and be relevant to their community reconnect with the public (Antoniou et al., 2013; Druin and Fast, 2002; Simon, 2010; Tinkler, M., 1998). Museums such as the Santa Cruz Museum (Simon, 2010) and the Kelvingrove Art Gallery and Museum in Scotland (Nielsen, 2015) have successfully pursued participatory activities where visitors are involved in the design of an exhibit or even in the redesign of the museum.

Among participatory design activities, **games** are well established (Brandt and Messeter, 2004; Iacucci et al., 2000). A subarea of HCI for many years (Malone, 1982), games are now experiencing something of a golden age, with substantial growth in publications and venues (Bernhaupt et al., 2015). In particular the increasing complexity of systems and interactions is fuelling new research into design processes to better understand how to integrate new technologies, and games are increasingly seen as an effective tool to explore new designs (Johansson and Linde, 2005), products (Benedek and Miner, 2002), and interaction techniques (Bernhaupt et al., 2015). Games are ideal as a participatory activity because they can effectively support user research (Deen et al., 2014) and user-centred design (Brandt and Messeter, 2004), which in turn is seen as a way to avoid poor design decisions (Iacucci et al., 2000). Games have also been successfully used to collect feedback about a product or experience, for example with the Microsoft Desirability cards (Benedek and Miner, 2002). Moreover, games can provide a common language (Muller et al., 1994), and promote an informal and social environment (Brandt and Messeter, 2004; Sanders et al., 2010). Duke (Duke, 1974) highlighted how games allow communication, especially with complex future-oriented topics.

Studies in game and design research have found that games can inform the design of interactive experiences (Bernhaupt et al., 2015; Isbister and Mueller, 2015; Wetzel et al., 2016), also in contexts other than games (Carter et al., 2014). Hypothesis have been drawn in the field of costumer research (Adamou, 2011) and other researchers have proposed that games can be used to collect data from and about users (Benedek and Miner, 2002). However, research in this direction and evidence supporting the case is still very limited in the museum field. Museums typically use games to support learning and engage visitors with their exhibitions (Beale and Villeneuve, 2011; Danks et al., 2007), rather than for the design of such exhibitions.

1.1.2 The Role of Games in Contemporary Society

Play is a key element of human society (Avedon and Sutton-Smith, 2015; Huizinga, 1949). In this section I will provide a definition of games and an overview of their current role in society.

Defining Games

Abt proposes a definition of game simply as *"a particular way of looking at*

something" (Abt, 1987). Therefore, we could consider anything as a game (Salen and Zimmerman, 2004). Parlett agrees that "*The word [game] is used for so many different activities that it is not worth insisting on any proposed definition*" (Parlett, 1999). Houtari and Hamari (Huotari and Hamari, 2012) suggest that conditions unique to games do not exist, that there are only design elements that are characteristic of games but not exclusive to games. How then do we recognize a game? Although we agree that in principle anything can *become* a game, it would seem helpful in discussing games to have some criteria to distinguish a game from 'anything' else.

Abt himself proposes: "A game is an activity (i.e. event) with rules among adversaries trying to win objectives" (Abt, 1987). Whitehill defines games as pastimes with a set of rules, a prescribed end, an done or more winners (Whitehill, 2008). Whitehill also distinguished games played indoor and outdoor from sports (Whitehill, 2008). Salen and Zimmerman elaborate that: "*A game is a system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome*" (Salen and Zimmerman, 2004, p. 80), where a system is "*a group of interacting, interrelated or interdependent elements forming a complex whole*" (Salen and Zimmerman, 2004, p. 64). Huotari and Hamari (Huotari and Hamari, 2012) observe that most game definitions refer to games as systems that require the voluntary involvement of players. However, all the above definitions and conditions (e.g. conflict, rules and systems) could also be true for other non-game experiences. Huotari and Hamari (2012) suggest 'gamefulness' could be the unique condition of games.

Drawing on this range of analyses, I define game-based activities as experiences that include the typical design elements of a game and are perceived by the players as gameful. But what are those design elements? Both Abt (1987) and Salen and Zimmerman (2004) suggest that rules are a central aspect of games. Huotari and Hamari (2012) also list rules as a characteristic condition for games. Sanders et al. (2010) suggest that rules should be carefully organized but they should leave space for freedom, particularly in participatory studies where games are used as a support for design. Games should be well structured but not fully controlled in order to leave space for creativity (Näkki and Koskela-Huotari, 2012). Elements of conflict, uncertainty and suspense are also characteristic of games (Huotari and Hamari, 2012). Although constrained by rules, games should offer challenge through such elements. Even if rules are necessary (Brandt and Messeter, 2004), presentation appears to be the biggest motivator for participants: the activity should, above all, "look like a game" (Lieberoth, 2014).

Types of Games

Human fascination for games is reflected in the variety of types of games we can find. There have been different attempts to classify games (e.g. Avedon and Sutton-Smith, 2015; Whitehill, 2008). For simplicity, I classify games in 3 main groups. Firstly, **table games**, which include a variety of sub-categories. For example,

board games such as chess and backgammon (Avedon and Sutton-Smith, 2015; Whitehill, 2008) are table games, but also card games such as poker and solitaire are considered table games (Avedon and Sutton-Smith, 2015; Whitehill, 2008). In this category I also include puzzle games such as Sudoku and role-playing games such as Dungeons&Dragons.

Secondly, there are a variety of **outdoor games**. Outdoor games include sport and athletic games such as ball games and target games (e.g. archery) (Avedon and Sutton-Smith, 2015), but also street games such as Stickball and Marbles. Lastly, the advent of digital technologies facilitated the rise of **digital games** including console-based videogames and online gaming. The development of mobile devices such as smartphones and tablets are also enabling ubiquitous and mixed reality games. The most successful example of an augmented reality game enabled by digital technology is probably Pokémon Go that reached 45 million daily users shortly after its launch in 2016 [1]. Pokémon Go is an Augmented Reality game developed for smartphones that encourages players to explore the real world in order to find Pokémon (a.k.a. "Pocket monsters") characters in the virtual world (Tabacchi et al., 2017).

Games as Form of Digital Entertainment

According to recent reports (DaSilva, 2016; De Prato and Simon, 2014; Vancouver Public Library, 2015) users around the world are mostly enjoying four forms of digital entertainment: film/TV, music, games and publishing. Among those, games are probably the most dynamic and faster growing industries in the 21st century (Egenfeldt-Nielsen et al., 2016; O'Hagan and Mangiron, 2004). In 2014 the games industry sales reached $64.9 billion globally, overtaking the music industry and approaching the film entertainment industry at about $90 billion (Egenfeldt-Nielsen et al., 2016). With an expected growing rate of 9,6% against the 'mere' 4.5% of the film industry (Egenfeldt-Nielsen et al., 2016), games hit $ 101,1 billion in 2016 and is expected to reach $ 128,5 by the end of 2020 (UKIE, 2017). While video games are a stable market, online and mobile games have an increasing number of users (Egenfeldt-Nielsen et al., 2016). For example, Pokémon GO surpassed 65 million of active users in April 2017 (UKIE, 2017) and the mobile Augmented Reality marked is indeed expected to hit 1 billion of users and $60 billion revenue by 2021 (UKIE, 2017).

Is not only that games are played by an increasing number of people, they also interest a diverse range of audience (UKIE, 2017). Gender is practically equal with 59% males - 41% females playing games globally, and 52% males – 48% females playing mobile games (UKIE, 2017). Players are not just children or teenagers as the average player age is 35 years old (UKIE, 2017). Players age is quite equally distributed as well: 27% of players is under 18 years, old, 29% 18 to 35, 18% 36 to 45, and 26% more than 50 years old (UKIE, 2017). In conclusion, games are a global phenomenon that interests a diverse range of users, from 10 to 65 years old, and

[1] *http://www.wired.co.uk/article/pokemon-go-first-anniversary-who-still-plays*

across many different countries.

While digital games have acquired a key role in contemporary society as one of the fastest growing industries in the entertainment market (Egenfeldt-Nielsen et al., 2016; O'Hagan and Mangiron, 2004), museums are currently using digital games mostly as a tool to educate with visitors. This is a missed opportunity since playing games is not only educative, but can also entertain, connect visitors with museum objects or historical sites (Beale and Villeneuve, 2011), and provide data form and about players (Beale and Villeneuve, 2011; De Angeli and O'Neill, 2018). Moreover, games have demonstrated to unlock visitors curiosity and imagination, to create memorable social experiences and even have a social impact (Beale and Villeneuve, 2011).

Why do people play games?

Apparently people consider video games both as an educative and a social experiences that can connect with friends and family (UKIE, 2017). Indeed, interaction with other people seems to contribute to both intention to play and individual gratification (Wei and Lu, 2014). Unsurprisingly, another factor strongly connected with motivation and gratification is enjoyment (Wei and Lu, 2014). Games can be played just for fun (Hamari and Keronen, 2017). But while "hedonic games are mainly played for enjoyment" (Hamari and Keronen, 2017), games are not made just for entertainment. Games can have instrumental purposes as well if they are played for their utility (Hamari and Keronen, 2017). Thus, depending by the game purpose, a person will be motivated to play mainly for individual enjoyment or usefulness. Independently by their purpose, games tend to rely on hedonic factors (Hamari and Keronen, 2017). For example, enjoyment can support utility (Hamari and Keronen, 2017). Ultimately, enjoyment or usefulness are connected and can influence each other.

This two elements of utility and enjoyment are further corroborated by Carter et al. (2014) who found that publications in game studies focus either on games and their play experience (hedonic approach) or trying to go beyond games' nature by looking at how they can benefit players (utilitarian approach). For instance, games can promote an informal and social environment (Brandt and Messeter, 2004; Sanders et al., 2010) that support communication (Duke, 1974), which is why games have been used in the past to enhance teamwork, improve the working environment and design new products (Muller et al., 1994). Games are indeed a well-established technique to promote dialogue, social interaction and collaborative design since the early stages of the design process.

1.1.3 The Rise of Game Jams

People are increasingly not only enjoying playing games but also making them. People gather together to develop a video game or non-digital game such as a board game or card game during events named Game Jam (GJ).

Defining Game Jams

The first reported Game Jam was organized in 2002 (Kultima, 2015a). Since then, GJs have grown in number and kind. For example, the GGJ went from 1600 participants in 2009 to 6500 participants in 2011 (Preston et al., 2012). During this timeframe, GJs have evolved a set of common rules (Fowler et al., 2013; Kultima, 2015a; Musil et al., 2010). For example, GJs have a limited timeframe, which means participants need to prototype rapidly, generally within 48 hours. The Global Game Jam (GJJ) suggests that the brief timeframe will "encourage creative thinking to result in small but innovative and experimental games"[2]. Games should also have a thematic constraint, which means participants cannot develop just any old game. Anybody can participate as a "jammer" although small teams are encouraged. At the end the results should be shared, e.g. online and/or through public presentations. Kultima (2015a) offers the following definition: "*A game jam is an accelerated opportunistic game creation event where a game is created in a relatively short timeframe exploring given design constraint(s) and end results are shared publically".*

Game Jams in the Museum Context

In the last five years, game jams have also been introduced in museums but again their use has been limited. Institutions have used game jams mainly as an educational tool. For example, in 2015 Milan's Museo della Scienza e della Tecnologia hosted JamToday, a game jam focused on the development and analysis of serious games. This game jam was organized as part of a bigger EU network that looked at how applied games can contribute to improving teaching and learning (Crombie et al., 2015). Also in 2015, the Getty Museum organized their first day and night game jam for students on the USC Games program[3]. For Fowler et al., game jams are particularly effective at teaching new skills because participants learn through practical experience and they can create their own meaning (Fowler et al., 2013). They suggest that learning is one of the main motivations for attending a game jam (Fowler et al., 2013). For Scott et al. (2013), game jams are an effective educational tool especially because they attract people from different backgrounds, including novices and students who are passionate about games but have just started learning how to design.

Game jams also "encourage social interaction through collaborating with the people in their team and other developers participating in the game jam" (Fowler et al., 2013, p. 2). After observing 470 game developers during the Nordic Game Jam 2013, Reng et al. (2013) reported that participants' main motivations for attending were to make games and meet people. In general, developers preferred to work in groups. Thus, game jams are important social events that can support not only creative design and prototyping but also collaboration (Locke et al., 2015; Musil et al., 2010). Because participants share interests and work closely together for 48

[2] http://globalgamejam.org/faq
[3] http://blogs.getty.edu/iris/a-night-at-the-museum-gettyusc-game-jam-is-back/

hours, Reng et al. argue that game jams can even help build communities (Reng et al., 2013).

Museums have also used game jams as social events, with the aim of connecting with local communities. For example, the Museum of the Moving Image in New York organized a game jam in collaboration with Groundswell, an organization dedicated to advancing the practice of public art-making. This event focused on understanding and learning game design principles and was also intended to support the local community[4]. Similarly, the Youngstown Game Developers (YGD) and the John J McDonough Museum of Art hosted the first Youngstown Game Jam in 2016 to support the local community. In particular, they wanted to provide tools to create jobs within the entertainment technology field[5].

Game jams have also been used successfully to involve visitors with museum collections (Mader, 2015). For example, National Museums Scotland organized a game jam for young people. Their intention was to use the event to allow young visitors to engage with museums' collections in new and exciting ways[6]. The Royal Ontario Museum (ROM) organized its first game jam in 2013 in partnership with the University of Toronto and has organized a game jam every year since with themes inspired by the ROM collections[7]. Global Game Jam (GGJ) events are hosted in locations around the world, recently including museums. The Swiss Museum of Games, the Helsinki Art Museum[8] and the Swedish National Museum of Science[9] and Technology each hosted a GGJ in 2016.

Despite museums' growing interest and participation in game jams as a visitor experience, the Royal Ontario Museum game jam is the only game jam hosted by a museum that has collected a (limited) set of data and published a short paper (Mader, 2015). The paper describes how a game jam could be used to explain planetary mission results to non-experts, allowing direct interaction with planetary materials and data. Thus, the study still focused on educational impact. Similarly to games, game jams have been used primarily as a tool to engage with the public, to connect with the museum collection. However, similar to Deen et al. (Deen et al., 2014), I propose that game jams can also be used to explore specific research questions, in particular to inform the design of user experiences for museums with their twin aims of educating *and* entertaining. In chapter 4, I will describe how data can be collected as participants *make* a game.

1.1.4 Why Gamefulness?

"The last 15 years has seen the rise of the digital game medium in entertainment, popular culture, and as an academic field of study. The success of digital games in the commercial entertainment industry (…) has spurred research into

[4] http://www.groundswell.nyc/game-jam
[5] http://eim-games.com/youngstown-game-developers-april-game-jam-2016/2016/03/29
[6] https://igdascotland.org/2015/09/national-museums-scotland-game-jam-project-opportunity/
[7] https://www.rom.on.ca/en/activities-programs/programs/game-jam
[8] http://globalgamejam.org/2016/jam-sites/fgj-helsinki-art-museum-0
[9] http://globalgamejam.org/2016/jam-sites/global-game-jam-stockholm

their effects and relevance in the digital age" (Seaborn and Fels, 2015, p. 1). As a consequence, games have extended their reach socially, spatially, and temporally (Walz and Deterding, 2015). As people increasingly enjoy to pass their time playing and making games, marketing and customer services have appropriated game elements and affordances in order to enhance users' engagement to hold users' attention (Hamari et al., 2014). Such affordances include for instance points, achievements/badges, levels, rewards, challenges and story/theme (Hamari et al., 2014).

Deterding et al. (2011) defines the use of game design elements in non-game contexts as gamification. Given that "game design is the practice of creating enjoyable interactions, it stands to reason that it holds something of interest to any domain in where interaction is designed and the goal is to make it more enjoyable" (Walz and Deterding, 2015, p. 9). One of the most famous examples of game elements applied to another domain is Foursquare, a mobile app that searches and suggests places to go to eat and meet people. The app allows uses to check-in at venues, including game elements such as points for checking-in, badges unlocked when specific conditions are met, competition with other users, and rewards (e.g. gifts and discounts).

Interest towards gamification is rapidly growing in both business and academic contexts. Gamification is so successful because games are an asset in contemporary society, they motivate users, increase engagement and happiness, stimulate perseverance and creativity (Deterding et al., 2013; McGonigal, 2015). Thus, it is no surprise that the number of research publications has been exponentially growing in the last 7 years (Hamari et al., 2014). For instance, researchers in human-computer interaction (HCI) and game studies are investigating the effectiveness of gameful systems to inspire the design of engaging users experiences and address HCI issues including tagging images (Deterding et al., 2013; Walz and Deterding, 2015). While research publications reveal that gamification has indeed positive effects, it is still unclear whether those positive effects are only short-term and caused by novelty or hold long term, even though it appears as stop using gamification has negative effects (e.g. loose all badges) (Hamari et al., 2014). Moreover, gamification is still a relatively young field of research and is still lacking of a common definition. For example, what does gamification means and what does it include? Is gamification everything game-related? (Walz and Deterding, 2015).

Deterding et al. (2013, 2011) focuses on game elements, but also emphasize that gamification is used to implement gameful experiences. While Huotari and Hamari (2012) directly talk about gameful experiences that provide the same psychological experiences as games and enhance user's overall value creation using affordances. Ultimately, "many researchers and designers now use the term gameful to talk about designed experiences and systems that work and feel like a game" (McGonigal, 2015, p. 655). In particular, McGonigal (2015, chap. 656) defined the term as "having the positive traits of a gamer" or "having the positive traits of a

game"[10]. Those positive aspects of games/gamers are orientation toward achieving **goals** and taking new **challenges**, **outcomes** focus, resilience and **perseverance** in facing obstacles, taking **pleasure** in completing tasks and **learning** new skills, **curiosity** and **creativity** (e.g. trying out different strategies) (McGonigal, 2015).

Playful vs. Gameful

This thesis focuses on enhancing visitors' experience by providing an experience that feels both entertaining and authentic. I attempt to do so by taking advantage of positive qualities of games in the museum context, to provide experiences that 'feel like a game', which is why I am using the term *gameful experiences* rather than gamification. I am also choosing to use the term *gameful* rather than *playful* because I am using game-based activities and games affordances with a purpose.

As the names suggests, gameful relates to games and playful to play (Lucero et al., 2014; Walz and Deterding, 2015). While play and game are often used as synonymous, play refers to a more spontaneous, 'purposeless' state (Brown and Vaughan, 2010), while game (a.k.a. ludus) is more formal (Lucero et al., 2014). For example, activities such as sketching and improvised construction with Lego are not driven by goals, so are considered play. Instead, games are outcome driven and goal oriented (Walz and Deterding, 2015, pp. 653–659).

Therefore, playfulness and gamification are two different concepts. Games are not just free play, they are set by rules and driven by a series of affordances such as points, stars and achievements that are used to motivate users and their behavior (McGonigal, 2015; Walz and Deterding, 2015). However, there is still play in games: "gaming simply happens to be a form of play that, in addition to creativity and curiosity, also requires hard work" (Walz and Deterding, 2015, p. 654).

What is the Gameful Museum?

Drawing on previous literature, I use the term gameful to identify a museum that *provides visitors with emotional and psychological experiences similar to games, using game-based activities and affordances (e.g. achievements, challenges and stories/themes) to stimulate participation, creativity, curiosity and perseverance*.

1.2 Research Questions

Games have an increasing reach in society and are seeing unprecedented interest in the academic world. For example, game-based activities have been used to inform the design of new products and user experiences. However, their use for research purposes in non-game contexts still remains little investigated. In particular, museums are using games mostly as an educational tool and not as a

[10] *https://www.urbandictionary.com/define.php?term=gameful*

method to collect data. Meanwhile, visitors are asking for experiences that are not only educative but also entertaining and relevant to them. Thus, museums have an opportunity to use games not only to educate and to entertain but also to collect data through which to better understand their public in order to design experiences that are more both interactive and meaningful for the visitors. In this thesis, we investigate how game play and game making can facilitate the design of new visitors' experiences. Our main research question is:

Can gamefulness promote authentic and entertaining experiences in museums?

In order to answer the main question, this thesis will address the following sub-questions:

- *What is authentic and entertaining in the digital museum?*

In order to answer my main research question, I first needed to define what is authentic and entertaining in the museum context. Thus, I identified issues related to authenticity and entertainment, in particular after the introduction of digital technologies in museums. Finally, I explored how authenticity and entertainment relate to visitors' satisfaction (see Chapter 2).

- *Can gameful activities empower museum professionals and support the design of interactive experiences?*

As my main research question focuses on gamefulness, I then investigated gameful activities in the museum context. In this particular sub-question I enquire whether gameful experiences can help overcoming museum professionals' struggles with digital technologies and participation. In particular, I engaged museum professionals with playing and making games (see Chapter 3).

- *Can game-based activities facilitate the understanding of what is meaningful and entertaining for visitors?*

Through my research, I have engaged with both museum professionals and the public. However, I have used game-based activities for different purposes. For instance, I used game play and game design with museum professionals to facilitate the introduction of gameful activities in museums. In parallel, I investigated gameful experiences as a mean to collect data from the public, produce knowledge and inform the museum context. Thus, I also engaged the public with playing and making games (see Chapter 4).

- *How do we evaluate visitors' subjective experiences in the gameful museum?*

Both authenticity and entertainment are subjective, dictated by feelings and personal experiences that are very complicated to access. So once we design a new visitors' experience, how can we evaluate whether it is perceived as authentic and entertaining? In order to answer this question, I investigated how museums are currently evaluating visitors' experiences, and how emotions and affective states are

usually measured. Thus, I proposed a method to evaluate visitors' subjective experiences and emotional states in museums (see Chapter 5).

1.3 Research Methodology

I address the research question - **can gamefulness promote authentic and entertaining experiences in museums?** - using a combination of methods including researching and evaluating literature in areas including visitor studies, game and design research, computer science (in particular Human-Computer-Interaction), museums, cultural heritage, archaeology, marketing and health studies. I also developed a series of case studies. The main approach was to collect data from and about users playing/making games and I also evaluated visitors' experience with interactive kiosks both in-lab and in-the-field (e.g. in museums of the National Trust).

What are authentic and entertaining experiences in the digital museum?

This sub-question is approached in Chapter 2 via literature reviews and empirical data collected during a workshop via direct observation and an approach based on KJ techniques. I investigated the concepts of authenticity and entertainment reading academic publications and reports (e.g. from museums and non-profit organizations), and running a thematic analysis of the notes taken during the workshop.

Can gameful activities empower museum professionals and support the design of interactive experiences?

This sub-question is addressed in Chapter 3 through two case studies involving museum professionals: a game play session and a game jam. Data was collected using a combination of qualitative and quantitative methodologies including direct observation and surveys with both multiple-choices and open-ended questions. Moreover, data was collected via audio-recordings and photos. The play session draw inspiration from directed storytelling, a design method.

Can game-based activities facilitate the understanding of what is meaningful and entertaining for visitors?

This sub-question is addressed in Chapter 4. Similarly to the previous chapter (i.e. Chapter 3) I present two case studies: a game play session and a game jam. However, this time I involved members of the public rather than museum professionals. Data was collected using a combination of qualitative and quantitative methodologies including direct observation, semi-structured interviews and surveys. Moreover, I audio-recorded the play sessions and took photos to record participants' choices and behaviour while playing games. The play session also draw inspiration from directed storytelling, a design method.

How do we evaluate whether visitors had an authentic and entertaining experience?

This sub-question is addressed in Chapter 5 via literature review, word

association tasks, and a combination of quantitative and quantitative studies including interviews and think aloud protocols. My main purpose was to propose a new method to evaluate visitors' affective experience in the museum. Thus, I searched and analyzed how subjective experiences and emotions are measured, and which methodologies are currently used by museums. In particular, I investigated Emoji as a means to assess emotions. This initial evaluation was needed to support the design of the Emoji-based method as described in Chapter 5. Thus, I run two word-association tasks in order to validate the meaning of a set of Emoji. Frequency analysis was calculated using R, a software environment for statistical computing. A 95% Confidence Interval (CI) was also calculated in order to provide a range of values for each frequency. Then, I organized two studies to collect additional data and verify whether the Emoji-based survey could effectively measure visitors' affective experiences. In the first case study, I used a combination of interviews and Emoji-based surveys, so that I could compare the data. In the second case, I collected visitors' comments about their experience using emoji cards as prompt. I also took pictures and recorded audio.

Table 1: An overview of the game playing (Play) and making (Make) sessions. For each activity the table indicates: the name of the activity (Activity); the order in which the activities happened (e.g. TADT was organized first, followed by GT, 1001DT and finally GL); and whether the activity involved museum professionals or the public.

	Museum Professionals (Chapter 3)		**General Public (Chapter 4)**	
	Timeline	**Activity**	**Timeline**	**Activity**
Play	3rd	1001 Dyrham Tales (1001DT)	1st	Tell-A-Dyrham-Tale (TADT)
Make	4th	GameLab (GL)	2nd	GameTale (GT)

1.4 Research Contribution

This thesis makes theoretical, methodological and practical contributions. The study draws on and contributes to scholarly literatures that examine the concepts of authenticity, entertainment and visitors' satisfaction. Through Chapter 2, I provide a definition for authenticity and entertainment in contemporary museums. I also adapt literature form gamification and game studies to the museum context. In the Introduction i provide a definition for the gameful museum that *provides visitors the same emotional and psychological experiences as games, and enhance user's overall value creation using game affordances (e.g. achievements, challenges and stories/themes), stimulating participation, creativity, curiosity and perseverance*.

Based on further investigation of Research through Design, game and design studies, i propose a new methodology to collect data from and about participants playing and making games. At the end of Chapter 4, i propose a set of guidelines to run similar studies and collect data to inform future designs. Thus, results of studies

described in Chapter 3 and 4 can facilitate museum professionals with the collection of data and the design new visitors' experiences. At the end of the thesis (Chapter 5), i also describe and validate a new method to evaluate visitors' affective experience in museums.

The contributions of this thesis are mainly to the fields of HCI, games and museums studies, but are not limited to these. For instance, the methodologies i illustrate through Chapters 4 and 5 can be applied to other fields such as Health and Marketing to collect data, design new products/experiences, and evaluate users' affective experiences.

1.5 Research Engagement

Through this research, I engaged with various non-academic stakeholders.

Museum Professionals Through this research, museum collections were digitalized and a series of games were designed for museums. I published templates of those games online and during workshops and conferences. Those templates are free to download and easily customizable according to museums individual needs. Thus, the games produced are freely available to any museum. Finally, I have laid the basis to create a new tool for museums to evaluate visitors' affective experience (see Chapter 5). A partial version of this toll is already available online and free for museums to download. Once completed, the final tool will also be freely available to museums.

General public I organized a series of events for the public. For example, I ran game play and making sessions in different locations involving **students**, museum **visitors** and the general public (see Chapter 4). I also set up showcases and public speeches to share digital artefacts and games to the public (see Chapter 4)[11].

Entertainment Industry I organized DiMEA, a two-day workshop to facilitate dialogue between museums, academics and professionals of the entertainment industry (see Chapter 2). This event promoted the creation of new collaborations between museums, academics and entertainment companies.

1.6 Research Outline

Chapter 2 presents an overview of the concepts of authenticity and entertainment, their evolution and how they related to visitors' satisfaction. I describe issues related to the design of authentic and entertaining experience and introduce the concept of co-design as a solution.

Chapter 3 uses game playing and making to empower museum professionals and promote the use of gameful experiences in museums. The chapter includes two case studies designed with the aim of helping museum professionals to embrace the

[11] *https://bathdigitalfestival.co.uk/events/tech:do/gametale.html*

introduction of interactive gameful activities: (1) a game play session with curators of the National Trust UK, and (2) a game-making workshop with museum professionals from different institutions. Thus, game play and game design can facilitate the design of interactive experiences in museums, but how do make these experiences relevant to the public? And if digital artefacts can be considered museum objects (see Chapter 2), how can we interpret them?

Chapter 4 focuses on visitors and illustrates how game playing and making can provide data from and about visitors, and how this data can be used to solve issues related to the museum context. For example, can game-based activities help to understand how digital artefact can be interpreted? Similarly to the previous chapter, I present two case studies: (1) a game play session with visitors to one of the properties of the National Trust to explore visitors' preference about narrative content and genres, and (2) a game-making workshop with the general public to investigate how digital artefacts can be interpreted and perceived.

Through Chapter 3 and 4 I investigated a series of gameful experiences to facilitate the design of museum experiences that are both authentic and entertaining. But how can we be sure that an experience is actually perceived as authentic and entertaining? Visitors' experiences are very personal and subjective, and affective states are complex to measure. Based on findings from Chapter 2, in **Chapter 5** I investigated how subjective experiences can be evaluated, and how to do so in a rapid and non-intrusive way. Thus, I designed and tested a new method to evaluate visitors' experiences in the digital museum.

In **Chapter 6** I conclude, summarizing the thesis findings and outcomes, describing limitations and identifying future projects to further promote and exploit gamefulness in museums.

Chapter 2

Authenticity and Entertainment in the Digital Museum

Museums have long been perceived as reliable and authoritative places of education (Graham, 2012). Together with libraries, they were historically the main providers of knowledge. But today information can be easily found online and new technologies are rapidly evolving, becoming an essential aspect of both our education and leisure activities. As society is rapidly changing, museums are required to adapt as well. This is affecting how museums relate to the public, how they design their exhibitions and interpret knowledge. In this chapter, I investigate how the concepts of authenticity and entertainment have evolved in the digital age and how this evolution is influencing visitors' expectations and satisfaction. The findings presented are based on literature review and supported by empirical data collected during a workshop that I ran on "*Entertainment and Authenticity in the Digital Museum*" (DiMEA)[12]. I organized DiMEA to provide a platform to explore how authenticity and digital entertainment can coexist in contemporary museums.

2.1 DiMEA Workshop

I have organized the workshop "*Entertainment and Authenticity in the Digital Museum*" (DiMEA) bringing together experts from the museum field, prominent researchers from computer science and design, and professionals from the entertainment industry in order to discuss their experience with authenticity and entertainment.

2.1.1 Setting

The venue of the workshop was Folly Farm, a restored 18th century farmhouse located in a 250-acre nature reserve with wildflower meadows and ancient woodlands. The farmhouse is complete with bedrooms, self-contained studio cottages, a professional kitchen, dining room and lounge area. Participants lived together in Folly Farm for two nights. Each participant had a private bedroom and could use the common spaces.

The workshop was organized in the conference space of the venue. Participants sit around a big table at the center of the conference room (see Figure 1). The

[12] *https://dimeaworkshop.tumblr.com/*

workshop lasted in total one and half days. The first day was organized in three panels with presentations on the topic of authenticity and entertainment (Section 2.1.3). Museum professionals shared their experiences during the first panel in the morning, followed by participants from industry (second panel) and university (third and last panel). During the morning of the second day participants took part in a planned discussion on topics and themes formulated during the workshop the previous day. The event closed at lunchtime the second day.

Figure 1: The conference room with the participants sit around a central table

2.1.2 Participants

The event involved 3 groups of participants: museums, professionals from entertainment industry and academics. In total, 17 participants attended the event: 5 museum professionals from Europe, working in science, art or history museums; 4 participants worked in or with entertainment companies in Europe, including augmented reality, special effects and design enterprises; 8 academics from different universities around Europe researching in a variety of fields including museum, game and computer studies.

At the beginning of the event, all participants received an information sheet and signed a consent form for photos but not video and audio recording. Video and audio recording were an issue especially for professionals from industry but also for some museums that did not wish to share confidential information.

2.1.3 Methodology

The event lasted one full day and one morning. During the first day, the workshop was divided into 3 panels. On each panel one group of participants presented case studies and perspectives related to authenticity and/or entertainment. Drawing from KJ techniques, I provided participants with sticky notes

and pens, inviting them to write an observation on a sticky note whenever a participant said or did something interesting or relevant. They could make one note per observation. Similarly to KJ approaches, participants wrote and post all the sticky notes simultaneously. In this way, participants could express their opinion without external pressure.

Participants could write on their sticky notes at any time but they had specific time allocated during the breaks in between presentations to write and post them. That way we made a more effective use of time and we could include more presentation, thus more perspectives, in the program. Participants were asked to post their notes in four posters placed in the room, according to affinity. Each poster asked a question:

1. What is authenticity?
2. What are issues related to authenticity?
3. What is entertainment?
4. What are issues related to entertainment?

For example, participants added notes associated with authenticity in the first poster but if the observation were directly related to issues related with authenticity, then the note would be posted in the second poster. I collected the posters at the end of the first day, reviewed the sticky notes, and checked for themes. The second day of the workshop, I used these notes as a stimulus to guide a focus group and elicit participants' perceptions about authenticity, entertainment, and related issues. I was present both days to listen, observe and take notes.

2.1.4 Data Analysis

I performed a thematic analysis of my notes taken during the workshop. Drawing from (Braun and Clarke, 2006) theory, the analysis followed a series of phases. First, I read all my notes to familiarize myself with the content. Then, I generated the first thematic nodes by writing bits of information into sticky notes and cluster them based on affinity or themes. At this point, these sticky notes were merged with the notes from the posters. Once I had identified thematic groups, I organized and copied them into a Word document. Thus, I reviewed the themes, checking for additional connections. Finally, I defined and named the topics discussed during the workshop.

Table 2: This table reports the content of the 3 posters. For example, it indicates what influences authenticity and entertainment according to our participants; what is considered authentic and entertaining with concrete examples; and what are the main issues associated to authenticity and entertainment.

	Authenticity	**Entertainment**
Influenced by	Personal motivation Personal expectations	
Definition	Subjective/personal perception Immersion/reenactment Reconstruction Accuracy Presentation/Form	Fun Engage Enjoyment Not edutainment Serious Educative Tell stories Stimulate feelings
Forms / Examples	People People's behavior/habits Setting Object Science Technology Dinomania Robots	Quizzes Augmented Reality Virtual Reality Games Theatre performance
Issues	Do visitors care? Personal perception Too personal can be an issue Real objects are not enough Form vs content What was like? Tragic/Dramatic Narrative Too focused means lost in clarity and engagement Authenticity is a barrier on its own Preconceptions Partial authenticity Reconstruction/restoration	Distraction Not authentic Superficial Blurred definition Achieve good design (e.g. content, length) Choose (wrong) medium When do we used it? Not always necessary Make it simple and solid Inappropriate Intrusive Personalization is risky Some theme is not entertaining Technology has limitations (e.g. calibration)

2.1.5 Findings

Through my analysis I have gained insights regarding participants' perceptions of authenticity and entertainment (see Table 2). I have also identified four major themes that were linked to both authenticity and entertainment during the workshop: narrative, digital technology, expectations management, and motivation.

Authenticity

This thematic group includes discussions related to the concept of authenticity, forms of authenticity, and challenges related to authenticity. During the workshop, museum professionals highlighted the importance of authenticity but also explained that the concept changes from one museum to another. In other

words, a science museum does not perceive authenticity the same way for example a history museum does. This makes sense especially if we consider that these museums have different collections, different priorities and different missions. For historical properties security and preservation of the artefacts has always priority over authenticity. For instance, they would add ropes and glasses to protect original artefacts.

Finally, the workshop highlighted there is often focus on material authenticity such as objects and buildings rather than intangible authenticity such as people behaviour and habits. For example, one of the participants talked about the videogame *Assassin Crew* where the developers are trying to reproduce authentic historical experiences. While the game succeed in replicating historical buildings, it fails to accurately represent how people behaved during a specific historical period. This often happens in historical properties were that focus on the objects and the building but sometimes failed to communicate the human intent behind the artefacts.

Entertainment

This thematic group includes discussions related to the concept of entertainment and forms of entertainment. While entertainment collected more notes in the posters than authenticity, the concept was rarely openly discussed during the workshop itself. Participants mainly focused on the difference between engagement and entertainment. In particular, museum professionals agreed that the term engagement is usually preferred to entertainment. Engagement evokes emotions and intellectually involves visitors. Instead, entertainment was associated mostly with fun, although it could coexist with engagement and education.

A wider discussion involved specific forms of entertainment such as games and theatre performances. For instance, theatre performances are entertaining but also educational, memorable, and motivate visitors to return. Theatre performances can be considered authentic as well. Likewise, games can be educational, immersive and tell stories that are both entertaining and authentic.

Narrative

This thematic group I include discussions related to the interpretation of information, the challenges of sharing knowledge and telling good stories. The workshop confirmed that a good narrative is essential for museums. Although telling stories is what museums do (Johnsson, 2006), this is not always an easy task.

For example, historical properties focus on the preservation of the physical property, displaying objects and furniture that are either originals or accurate replicas. These houses are not empty but were once lived, people used the fireplace and sit on the armchair. As a museum, the space is quiet but would not be like that in its original forms. A house would be full of noises: children playing, birds tweeting, people talking. This is true for historical museums that were once a work place

rather than a house. For example, the Ruhr Museum in Germany is housed at the site of the former coalmine Zeche Zollverein, a UNESCO world heritage site. However entering the museum, visitors would not hear the classic noises of a coalmine. The machineries are still there, perfectly preserved, but not their noises. We cannot hear and see the miners using these machineries.

Telling the stories of the people who once lived or worked in the property is as important as the preservation of the house itself. Museums displays representations of the old inhabitants of the property from paintings or photos hanged in the walls, but we often do not see the person behind the representation. Paintings and photos are only objects, artefacts in a museum, and telling the story of the people illustrated in them is not an easy task. Moreover, museums often know what they have but not what they are missing. In other words, museum professionals may also miss bits of information.

In order to tell good stories, museum professionals suggested using themes. Volunteers are also very important as most visitors still prefer to interact face-to-face rather that reading labels. Finally, academics suggested taking inspiration from games might help, for example using challenges, stimulating curiosity and emotions to make the narrative more engaging.

Digital technology

This is one of the biggest thematic groups and includes various discussions related to digital technology and challenges due to their introduction in museums. During DiMEA, we discussed different forms of digital technology such as video games, mobile apps, augmented reality and Virtual Reality (VR).

Each technology presented potentials and challenges for museums. For example, VR is immersive and sensorial but it can be uncomfortable to use and wear. A participant working with the entertainment industry confirmed that VR are extremely immersive and for that reason they can also be very unsettling. He described a particular VR experience where users could enter inside an avatar head to learn more about what that character was thinking. The experience of enter someone head was so realistic and immersive to result unconformable.

Digital technologies tend to bring physical challenges, especially in historical properties where for example there is often no WiFi or where the heat produced by machines can raise security issues for the artefacts. Technology can be also considered disruptive of the museum experience or even inappropriate and unreal in contexts such as difficult heritage sites. Moreover, hardware and software have their own physical limitations. For example, VR requires calibration in order to work.

Finally, maintenance and sustainability are also mayor issues for museums. Technology may broke and visitors may behave unexpectedly. For example, what if a visitor decides to lay down on the ground instead of waving the hand to interact with the system? The system will probably not recognize these actions and not work.

Expectations Management

Within this thematic group I include discussions related with communicating with visitors, understanding their needs and expectations. Previous experience with museums and preconceptions influence how the public perceives their visit and what they expect. Designing and interpreting content in a novel way can be particularly complicated because visitors expect their visits to be structured in a specific way, their audio guides to work like any other museum guide. While younger audiences have fewer preconceptions, it is still important to communicate with everyone clearly. For example by using commonly know interfaces while proposing innovative content. People do not know what is authentic, so if it is not clearly communicated, they may perceive the museum experience as not authentic.

Motivation

Within this thematic group I include discussions related to visitors' motivation to visit the museum and return. Entertaining experiences, participation and shared spaces are all presented as powerful motivators. For example, theatre performances are memorable experiences that can motivate visitors to return. Involve the public directly with the design process can also create deeper bonds and motivate recurring visits. Finally social experiences can motivate returning visits and can be facilitated by the creation of shared spaces where visitors can interact with each other.

2.2. Defining Authenticity

Traditionally, museums are object centred, conveying knowledge through real objects. No reproduction could be considered authentic, just the real original object. The authentic object is what appears or claims to be unique, original, real, or natural (Castéran and Roederer, 2013; Land-Zandstra et al., 2018; Ram et al., 2016; Zerva, 2015). In other words, objects are considered authentic if they arise from nature (e.g. fossils), are unique (i.e. there are no copies), originate from the real word (i.e. outside the museums), or are historical artefacts (Land-Zandstra et al., 2018). Participants of DiMEA corroborate the idea of authentic objects as original or accurate (see Table 2). However, the workshop also introduced the idea that authenticity should not be related only to tangible heritage such as buildings and artefacts, but also to intangible heritage such as social practices and rituals. For example, the way people dressed and behaved during a specific historical period should also be preserved and accurately presented.

Visitors tend to relate authenticity mostly with objects because of their previous experiences, especially with the traditional historic house model where museum curators held the power to define which object was authentic and which one was not (Evans et al., 2002). Curators' decisions were based on their personal

knowledge and experience, and objects were displayed as they were, without human intent (Evans et al., 2002). In general, people assume that museums collections are 'real' (Fu et al., 2015) and if a museum chooses to display an object, it is because the museum recognizes their objective value (Chamberlain, 2011; de Rojas and Camarero, 2008).

However, society changed and so do people and their perception of the world (Castéran and Roederer, 2013). For example, in modern times the need for authenticity shifted from the Victorian obsession of 'original' objects to seeking real experiences (Evans et al., 2002). Thus, the concept of authenticity evolved from its original approach, moving away from the objects themselves (Zerva, 2015). The object-based approach related to authentic culture, time and place (Zerva, 2015). The constructivist perspective viewed authenticity as a matter of interpretation, a social construct that changes with culture, and so is more related to audience and society that inherent to the objects (Castéran and Roederer, 2013; Gnoth and Wang, 2015; Wang, 1999). The postmodernist approach goes even a step forward: authenticity has an interpretative value, meaning that is not an inherent property of objects (Shepherd, 2015), and it is also not relevant as consumers are unable to recognize it (Hede et al., 2014). According to this view, the only way to interpret authenticity is though clues, for example, whether an experience, an object, or a place match our goals (Hede et al., 2014). Moreover, authenticity is sometimes seen as an existential concept, something that is not only a matter of personal interpretation but can also be found just within ourselves (Rickly-Boyd, 2013).

Authenticity is increasingly seen as a consequence of how visitors perceive their experience, their personal feelings more than just an absolute status of the objects (Bryce et al., 2014; Hede et al., 2014; Steiner and Reisinger, 2006). Nowadays, the "perceived authenticity on an object outweighs the objects actual authenticity" (Land-Zandstra et al., 2018, p. 10). Perceived authenticity is influenced by personal goals, beliefs, expectation and previous experiences with museums (Eberbach and Crowley, 2005; Shepherd, 2015; Wang, 1999). Moreover, people usually perceive objects in two layers: (1) the objects external appearance and (2) a deeper level related the history of the objects, its contact with someone historically important or its association to an important event (Land-Zandstra et al., 2018). During DiMEA, authenticity was discussed not only in terms of material objects or buildings but also related to intangible aspects such as peoples' behavior and habits. The artefacts were once used and if their history is not tied to their human intent, then visitors' perception of authenticity may suffer. For example, "children seem to construct the authenticity of an object from a combination of appearance and background story" (Land-Zandstra et al., 2018, p. 12).

DiMEA highlighted how objects do not need to be authentic as long as their presentation is authentic. Indeed, visitors do not always distinguish authentic objects from replicas (Land-Zandstra et al., 2018). As long as replicas are very accurate, authenticity does not negatively affect visitors' experience (Land-Zandstra et al., 2018). Hence, we can argue that authenticity is a very subjective and dynamic

concept determined by personal perception. Authenticity is *personal* because is inspired by personal feelings and emotions (Bryce et al., 2014; Liao and Ma, 2009). Authenticity is also *relative* because it is culturally constructed (Hede et al., 2014). Society, the environment where we grow up, affects how we think, what we are interested in, as well as our desire for integrity and authenticity (Hede et al., 2014).

In this context, the real challenge for museums today seems to be the management of the people' perception of authenticity, which is why it is increasingly important for museums to understand what visitors need and expect from a museum experience and adjust with what museums can realistically deliver (Cameron and Gatewood, 2000). During the last couple of decades, museums are increasingly trying to offer a more stimulating environment where visitors can actually experience the artefacts, moving from an object to a more visitor-oriented focus (Antoniou et al., 2013; Falk and Dierking, 2000; Kelly, 2006).

Following a visitor-oriented approach, authenticity is not only an objective aspect of the museum and its collection but it is also relative to visitors' personal experience. Based on literature review and on the findings from DiMEA, I identified two main dimensions of authenticity:

(1) Objective authenticity, where I identify as authentic a museum object that is original, unique or existing in nature. Objective authenticity can be both tangible (e.g. related to material objects and buildings) and intangible (e.g. related to social practices and rituals).

(2) Subjective authenticity, which indicates people's perception of how genuine and meaningful an experience is for them. If authenticity is indeed subjective, then even if the environment where the visit happens is artificial, the experience itself can be still genuine because it depends on factors not inherent to the object, such as visitors' background, interests and whether they visiting alone or in company (Bruner, 1994; Hargrove, 2003).

Thus, as DiMEA participants emphasized, reconstructions and form of immersion, re-enactment can also be considered authentic, depending on how they are presented, the format they take. As a consequence, perfect and credible reproductions can also be considered authentic (Bruner, 1994; Castéran and Roederer, 2013), which means that our personal experience with both the originals and the copies would not probably differ much from each other. But if this is true, then what can we consider as (authentic) museum object?

2.2.1. What is a Museum Object?

Since 1965, multiple definitions of museum objects have been shared (van Mensch, 1990). According to one of the first definitions, the museum object is a piece of heritage, a real object (Stránský, 1981; van Mensch, 1990). But recent discussions highlighted how we might need a wider definition (Evans et al., 2002). For example, should the definition of museum object include objects of nature, in

particular living objects such as plants (Eberbach and Crowley, 2005; Evans et al., 2002)? Moreover, recently museums collections evolved further because of the process digitalization. Museums have increasingly been using digitalization as a tool for the preservation and research of physical objects (Langer et al., 2014a; Wachowiak and Karas, 2009). Thus, museums now own a growing archive of digital assets (such as digital photos and 3D models).

Similar to physical objects, these archives of digital asset are either stored in a fairly isolated way, their use restricted in term of sharing (Barreau et al., 2014), or are shared with the public (Langer et al., 2014a). With **digital content or assets** I mean: "*Any museum object that has been somehow digitalized, whether using a 3D scanning, a normal scanner or simply a video or photo-camera".* Whether the museums objects are digital or not, the visitors still expect the museums to present authentic content (Chamberlain, 2011). Visitors will also expect to learn something about those objects (Antoniou et al., 2013). As participants emphasized during DiMEA, it is important for the digital content to be presented in a truthful and genuine form in order to meet visitors' expectation and maintain authority.

Therefore, a wide range of assets can be considered real museum 'objects' in the digital age. During DiMEA, participants listed people, settings, objects, science and technology. Since modern society is influenced by the rapid evolution of technology, it makes sense for museums to conserve and exhibit for example industrial machineries, robots, games consoles and video games. In conclusion, nowadays the definition of museum objects goes beyond the traditional idea of tangible museum artefact. For example, museum objects can be digital, living (e.g. plants) and moving (e.g. robots), as well as intangible such as traditions and languages. Moreover, each museum object accumulates meta-data, documents and stories through time. A set of information that evolves with the objects and that is communicated and shared by the museum together with the real objects. Therefore, we can argue that a **museum objects** is**:**

> *Any tangible and intangible asset preserved by a museum, alongside with its related meta-data, such as information (labels), documents, and stories.*

2.2.2. Measuring Authenticity

Authenticity is a multidimensional concept (Bruner, 1994; Lu et al., 2015) and has been researched for decades, attracting interest from both researchers and consumers, especially in the field of marketing (Morhart et al., 2013), tourism (Castéran and Roederer, 2013) and cultural heritage (Nezhad et al., 2015). Mostly, researchers have been using interviews or surveys to capture objective dimensions of authenticity. For example, (Morhart et al., 2013) run a series of interview to interpret brand authenticity according to four dimensions: continuity, credibility, integrity and symbolism. With continuity (Morhart et al., 2013) was looking at brand history, its stability over time and capability of persisting in future. For instance, we

can think of a product having always the same ingredients. Credibility instead looks at the honesty and trustworthiness of a brand, so for example if a product or service deliver what was promised. Integrity looks at the intentions and values that are being communicated and whether there is a moral purity and responsibility without economic agenda. Finally, symbolism reflects audience's values and looks at how the product connects and relate with those values. In this sense, symbolism serves to construct identity and authenticity in general is evaluated accordingly to how a brand is communicated, delivered and able to reflect expectations.

Following data from those interviews, (Morhart et al., 2013) then created a Likert-type scale to capture the above four dimensions. The survey included 15 items shared among the four dimensions. For example, to measure continuity, the questionnaire would ask if the brand is timeless and has history. While credibility was evaluated asking about brand honesty and ability to accomplish what is promised. In order to capture integrity, the survey asked for instance if the brand cared about consumers and had moral principles. Symbolism was investigated by asking if the brand added meaning to people lives and try to connect with them. (Napoli et al., 2014) also developed a Likert-scale to capture different dimensions of authenticity. Initially, the survey included 157 items and encompassed 7 dimensions of authenticity (brand heritage, quality commitment, craftsmanship, sincerity, nostalgia, cultural symbolism and design consistency) and went then down to 33 items, focusing on three main dimensions: (1) quality commitment, (2) sincerity, and (3) heritage. Thus, the survey questioned the quality of the brand, its honesty and ability to not compromise. But it also investigated the brand *heritage*, its originality and connection with a specific historical period and culture. For example, if the brand is part of national treasure or has a strong cultural meaning, then we can talk about brand heritage (Wiedmann et al., 2011). Similarly, research in *cultural heritage* emphasizes how authenticity is related to design, aesthetic and history (Ram et al., 2016). Already in 1978, the World Heritage Committee identified 4 criteria to evaluate whether a heritage structure was authentic or not (Nezhad et al., 2015): (1) design, (2) materials, (3) workmanship, and (4) setting.

But authenticity is not only an objective value inherent to an object, place, or brand. It is also a subjective perception, meaning that it depends on whether audience is feeling a connection with the heritage site and its history (Ram et al., 2016). The World Heritage Convention of 2003 recognized that authenticity is a relative term, influenced by a set of values, not only historical but also aesthetic and socio-cultural (Murphy, 2007). Therefore, it is important to also access subjective feelings such as enjoyment, sense of belonging and connection (Ram et al., 2016). However, personal feelings are not easy to access, mainly because they are personal and intangible (Scott, 2011). Chapter 5 presents an overview of methodologies used to investigate emotions, including our own solution.

2.3. Defining Entertainment

Entertainment is a well-known term related to a multi-billion dollar industry that engages people globally (Collis, 2017). However, surprisingly research about entertainment is still very limited and its definition is more complicated that expected (Collis, 2017). This is due to the facts that perception of what is entertaining is incredibly subjective (Collis, 2017), depends on personal taste (Vorderer et al., 2004) mood (Zillmann and Bryant, 1994). Moreover, entertainment is a multidimensional term that can be seen as pure entertainment as well as leisure (Collis, 2017). Leisure addresses more active participation (Bates and Ferri, 2010) such as playing sport or music (Collis, 2017). While pure entertainment involve '*being entertained*', thus more passive activities such as listening to music, watching TV or a theatre play (Bates and Ferri, 2010; Collis, 2017). This distinction is always been critical and is increasingly becoming obsolete with the growth of more interactive forms of entertainments such as electronic games and VR (Bates and Ferri, 2010). In general, researchers in the field still see entertainment as *mostly* a passive communication between an audience and a text or artefact (Bates and Ferri, 2010). Unfortunately, industries tend to not discuss nor publish their definition of entertainment, so that any definition over entertainment is originated from different research groups. Since entertainment companies attended DiMEA, we could discuss their perspective as well.

Participants of DiMEA agreed with researchers such as (Bates and Ferri, 2010; Vogel, 2015) that an entertaining experience should be fun, enjoyable, pleasant (see Table 2). Clearly if the audience is having a boring and unpleasant experience, then it is not entertained: "entertainment is that which produces a pleasurable and satisfying experience" (Vogel, 2015, p. 4). But whether the experience is pleasant depends on audience perception, which emotional responses are stimulated (Zillmann and Bryant, 1994) and if particular needs are addressed (Bosshart and Macconi, 1998). Thus, it is important to understand the target audience in order to create product and services that are adapted to suit the public (Collis, 2017). Thus, entertaining is an audience-centered concept and as such it happens when there is some form of communication between audience and text or artefacts (Bates and Ferri, 2010; Hebdige, 1988), between one or more individuals and an external stimulus, such as TV show, a game or even a museum exhibition (Bates and Ferri, 2010). This perspective reflects the origin of the word *Entertainment*, which derives from Latin *inter* (= *among*) and *tenere* (= *hold)*, and it is interpreted as person/people focusing attention on one or more objects (Bates and Ferri, 2010). Participants of DiMEA envision those objects to include a range of digital technologies such as games and VR. Therefore, I define **entertainment** as:

> *A pleasant experience that happens when one or more external stimulus hold one or more individuals' attention.*

2.3.1. Entertainment vs Engagement

During DiMEA, museum professionals pointed out that museums usually refer to visitors' engagement rather than entertainment. So, why are we talking about entertainment? Entertainment was previously defined as a pleasant experience that happens when one or more external stimulus hold one or more individuals' attention. Similarly, the Cambridge Dictionary defines engagement as being involved with something or encourages people to be interested in something. Thus, engagement can be seen as an interaction between subjects and external stimulus such as objects and tourist attractions (Taheri et al., 2014). This external stimulus should first attract audience' attention, then maintain attention and encourage a continuing relationship so that audience return to engage (Taheri et al., 2014). If we look at the definition of entertainment and engagement, we might be tempted to use them as synonymous. Instead, we distinguish the two concepts, which is why we are using entertainment rather than engagement.

Entertainment is related to a pleasant but passive activity such as watching a movie (Bates and Ferri, 2010; Collis, 2017), while engagement usually indicate a more active attention, something that requires a level of effort, that hold our interest but it is not necessarily enjoyable (e.g. visiting a museum exhibition or attending a lecture at university). In other words, entertainment is fun and passive, engagement is serious and active. However, today entertainment is both passive and active because of the development of interactive forms of digital entertainment. Digital entertainment uses digital stimulus such as a games or a virtual reality experience to attract and hold visitors' attentions. However, entertainment still differ from engagement because of its focus on recreation more that reflection, a fundamental difference in a digital age where 'recreational' motivation influences visitors' engagement more than 'reflective' motivations (Taheri et al., 2014).

2.3.2. Measuring Entertainment

Users' engagement with digital technologies is often measured using multidimensional scales. In 1997 (Webster and Ho, 1997) proposed a 7 items questionnaire to evaluate user's engagement with multimedia presentations, including dimensions such as users' attention and interest. (O 'brien and Cairns, 2015) proposed 6 dimensions system to evaluate online news environments, including: (1) aesthetic appeal to evaluate attractiveness and appeal; (2) usability that look for example at whether the user is frustrated, confused, annoyed or tired; (3) users' involvement; (4) focused attention which can be captured for instance by asking whether the user lost track of time and felt absorbed; (5) if the product/service is considered a novelty, thus if the user is curious, interested; and (6) outcome/endurable experience if the product worked as planned and if it recommendable. (Wiebe et al., 2014) focused on 4 variables to study levels of engagement with video-games: (1) usability, (2) aesthetic, (3) attention, and (4) satisfaction. (O'Brien and Toms, 2010) investigated user engagement with

educational multimedia focusing also on aesthetic, focused attention/absorption and perceived usability of the multimedia.

Those scales share 3 main dimensions: aesthetic, usability and focused attention. The *aesthetic* factor captures whether a product or service is appealing (O 'brien and Cairns, 2015). *Usability* instead evaluates whether the product or service is easy and effortless to use, and so impacts users' capacity of achieving a goal, the effort required and final satisfaction in using the system (IWARSSON and STÅHL, 2003; O'Brien and Toms, 2010). *Focused attention* is probably the dimension that most embodies the concept of entertainment, which literally related to an object or person holding attention.

Focused attention derives from studies on flow state. Adapted from sports studies, flow state was initially defined as happening when a "performer is totally connected to the performance' (Jackson and Marsh, 1996, p. 1). "When in flow, a person becomes totally involved in an activity and experiences a number of positive experiential characteristics, including freedom from self-consciousness and great enjoyment of the process (Jackson and Marsh, 1996, p. 2). Flow state was evaluated using initially a 54 items scale, then reduced to 36 [Jackson & Mash 1996] and eventually adapted to other areas of investigation including learning (Kato and Suzuki, 2010) and computer-based activities such as games (Ma et al., 2014; Wiebe et al., 2014). Flow scales would enquire for example about levels of attention and concentration, skills and challenge, distorted sense of time, increase learning and attitude change (Jackson and Marsh, 1996; Kato and Suzuki, 2010).

In addition to multidimensional scale, users' engagement has been measured also with direct observation, interviews and biometrics. For example, (Konradt and Sulz, 2001) observed changes in users' affective and cognitive states during interaction. And Champion (Champion and Dekker, 2011) uses biometrics to gather data about for example users' heart rate, biology and mouse clicks. However, interview and direct observation are time consuming and have reliability issues (Mandryk et al., 2006). While biometric data is registered using sensors such as eye gaze that are often intrusive (Seah and Cairns, 2008). Moreover, those methods are objective, but they do not capture users' cognitive reaction, their emotional state (Seah and Cairns, 2008). But entertainment depends mostly on personal enjoyment and interaction rather than objective dimensions such as productivity and performance (Seah and Cairns, 2008). In other words, entertainment is subjective rather than objective. And since entertainment is so strongly influenced by subjective aspects such as motivation and emotional response, objective measures are not enough to measure users' engagement (O 'brien and Cairns, 2015).

Subjective aspects have been accessed in the past using self-report methods such as interviews, focus groups, and scales (O 'brien and Cairns, 2015). For instance, (Mandryk et al., 2006) designed a 5-point scale to measure users level of entertainment with technology. The scale investigated whether the experience was perceived as fun, engaging, boring, easy, challenging, exciting, and frustrating

(Mandryk et al., 2006). Those methods can provide data about emotions and attitudes, but they usually have limited success because emotions are difficult to classify and answers might not reflect the actual experience (Mandryk et al., 2006).

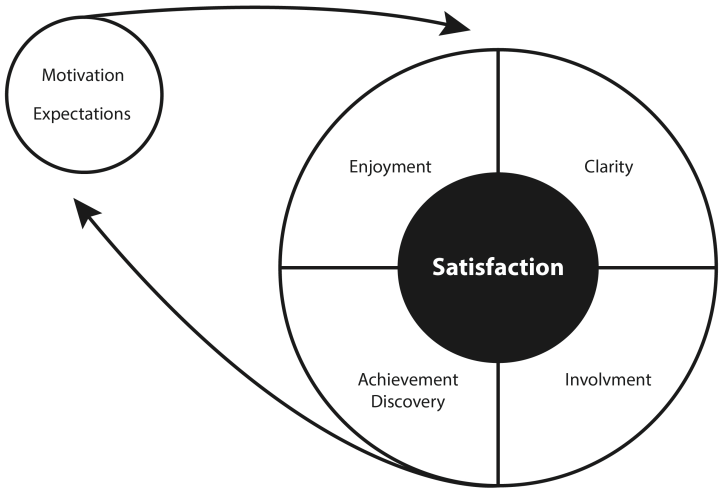
2.4. Visitors' Satisfaction

In sections 2.2 and 2.3, I illustrated how the perception of both authenticity and entertainment is very personal and is dictated by a variety of factors such as social context, personal motivation, education and expectations (Bryce et al., 2014; de Rojas and Camarero, 2008). For instance, visitors' perceptions of the museum experience is affected by whether their expectations are met (Bryce et al., 2014), they felt engaged (Bryce et al., 2014) and involved (Lu et al., 2015), and they perceive the museum service as adequate (Lu et al., 2015). Through DiMEA, personal expectations, motivation and clarity of communication were directly related to the perception of authenticity. In other words, how the object appears, how is presented, and whether its story is clearly conveyed or not influences how that same object is perceived.

If the museum narrative is clearly communicated, then visitors are more likely to perceive it as authentic. If visitors find the narrative authentic and relevant to them, they might also learn and feel achieved. If visitors feel achieved and perceive their experience as authentic, then they are more inclined to care for what the museum has to offer and they feel more involved. Involvement defines some kind of social participation (Chen and Chen, 2010), where people feel part of the museum, and the museum part of the community. During DiMEA, social participation was also presented as a strong motivator to repeat a visit. Moreover, if visitors feel involved and achieved, then they will probably enjoy their visit.

In conclusion, *visitors have **satisfying experiences** as a result of the total museum experience* (see Figure 2). Thus, whether visitors felt *achieved and/or acquired new knowledge*. If the *narrative was relevant and clear*. In other words, if the narrative aligned to visitors' personal motivation, expectations and interests. If the narrative was also being communicated clearly to the public. Finally, if visitors felt *involved* and *entertained*, so if they enjoyed their visit.

Figure 2: Motivation and expectations influence the visit. Satisfaction is personal and results from a variety of factors, including quality and clarity of the narrative, involvement, sense of achievement and discovery, and enjoyment.



2.5. Issues with Authenticity and Entertainment

The investigation of authenticity and entertainment are central for museums in the digital age as their perception influence visitors' satisfaction, which is antecedent of visits frequency and visitors loyalty (Bryce et al., 2014). However, research connecting authenticity to entertainment and satisfaction in museums is still very limited (Bryce et al., 2014). In this chapter I am partially filling this gap by emphasizing which issues they share and which ones can be caused by their coexistence.

First, authenticity and entertainment are very **subjective** because they derive from personal expectations, feelings, interests and motivation. People can feel pleasure when they are having fun, when they are happy, but also with strong emotions. Take for example the experience of reading a melancholic book that provokes intense emotions. We would say that the reader actually liked the book and find it particularly authentic, meaningful. Because it is such a personal experience, some visitors might not even care about authenticity, like a reader could be completely indifferent to the same book. While other visitors might have pre-conceptions, which are not always easy to overcome.

During DiMEA, a museum professional illustrated the example of a new open-ended guide that was designed to be more personal and entertaining. However, the new audio guide did not work as visitors expected and was poorly communicated. Thus, **personalized** experience can be appealing and relevant for visitors, but they are also very risky and complicate to implement properly. A poorly designed application can hurt the perception of both entertainment and authenticity.

Authenticity and entertainment are also **complex to balance** with each other. In particular, storytelling has always been seen as an engaging and appealing way of communicating with visitors (Chamberlain, 2011), but museums are struggling to balance entertainment with the accuracy of the story, to represent the plurality of each culture, and to make the content accessible to a heterogeneous audience (Carr and Cohen, 2015). On one hand, historical authenticity is important to maintaining the authority that so strongly defines museums, but it is not always engaging for the general public. On the other hand, powerful narratives can reach audience more efficiently. But the borders between truth and fiction are sometimes hard to define and dangerous to navigate (Chamberlain, 2011).

During DiMEA, participants also highlighted how both authenticity and entertainment are **costly** and require expertise. For instance, buying and maintaining digital technology is expensive. Most small-medium museums cannot afford to hire either personnel with technical skills or an external company to design interactive experience. The issue is not only implementing and maintaining digital technologies, but also selecting the right one from the beginning. Moreover, the design of authentic experiences requires for the museum to understand the visitors and their needs. This means to organize interviews, focus groups, workshops and so on. But all those activities require time, money and human resources.

The museum itself as a physical structure can limit both authenticity and entertainment. For example, participants at DiMEA complained that museums often have limited access to WiFi. Finally, authenticity and entertainment can **limit each other**. For example, if a museum focused too much on authenticity, then they might loose in clarity and engagement. In this sense, authenticity can be a barrier for museums, a distraction. And often, real object are not enough to drive people attention. In turn, entertainment is often seen as a distraction from the museum real experience, it's artefacts.

Technology is sometimes seen as inappropriate, superficial, and disruptive of the museum experience. In particular, some themes and places are considered too 'sensitive' to be intruded by technology and in general forms of entertainment. And museums often do not have the technical competence and the experience to know which technology deploy and when, what are the limits and the potentials of certain technologies. For example, during DiMEA participants briefly discussed pros and cons of BYOD (i.e. Bring-Your-Own-Device). On one side, if visitors download an app (e.g. the museum guide) into their phones, then the museum does not need to buy and maintain a set of mobile devices. On the other side, museums need to properly communicate the museum app both online and onsite, to develop the app for different devices, to publish the app via different online stores, and to provide a stable and secure Internet connection. Museum professionals need to be informed about those pros and cons in order to take the decision that better fits the needs of their institution and their visitors.

2.6. Designing for Authenticity and Entertainment

Design museum experiences that are both authentic and entertaining can be particularly challenging for museums (Section 2.5) and traditional methods might not be appropriate. For example, museums usually organize design workshops involving experts, curators and educators who are given specific topics or visitor's personas (e.g. a teenager) to design for (Roussou et al., 2015). In this approach the user is not really a part of the team, it is just spoken for by the designer/s. But for museum to be relevant, to design experiences that are both authentic and entertaining, it is important to communicate directly with the public, to understand and respond to their needs and interests.

Other more traditional design research methods focus primarily on observational research and focus groups and interviews. Through direct observation, museums look at what people do and use in the exhibition, understanding how visitors interact with the museum. Instead groups and interviews look at what say and think, so they open a direct dialogue with the visitors. However, either of those approaches actively involves visitors in the design process. While if people participate to the design process, then museums can understand what is **relevant** to them prior to their visit, reduce the risk of failure and **meet visitors' expectations** (Chen and Chen, 2010).

Participatory practices such as collaborative workshops shift attitude from designing for users to one of designing with users (Sanders, 2003). The roles blur and the user becomes a critical component of the design process. Participation provides a platform for dialogue (Sanders, 2003), so that visitors can *contribute, discuss, create their own meaning and connect* (Simon, 2010)**.** Moreover, during DiMEA participation was presented as a tool to connect with the public and motivate their visits. When visitors are involved directly in the making of the museum experience, they feel more involved (both individually and socially) and consolidate their relationship with the museum. Therefore, cultural institutions become more accessible, part of the socio-cultural life of a community (Falk and Dierking, 2000). As a consequence, participatory design has proven to be a successful method to develop museum experiences that are **both authentic and entertaining** (Antoniou et al., 2013; Druin and Fast, 2002; Simon, 2010; Tinkler, M., 1998). For example, museums such as the Santa Cruz Museum (Simon, 2010) and the Kelvingrove Art Gallery and Museum in Scotland (Nielsen, 2015) are pursuing participation activities where visitors are involved in the design of an exhibit, or in the re-design of the museum.

2.7. Summary

Both authenticity and entertainment are complex to define in the museum context. Both concepts are very subjective. Moreover, authenticity has evolved through time, adapting to society. There is also a tendency to refer to engagement

rather than entertainment in museums. The word "entertainment" itself is often not associated with museums. I researched existing knowledge related to authenticity and entertainment in a variety of areas including museum studies, tourism, and entertainment industry. I identified definitions and interpreted them in the museum context. These findings were further corroborated by empirical data collected during DiMEA, a workshop I organized to discuss the concepts of authenticity and entertainment in contemporary museums. Museum professionals, academics and entertainment companies joined the conversation during the workshop. Drawing from both literature review and workshop outcomes, I provide the following definitions:

Authenticity has two main dimensions. First, objective authenticity where I identify as authentic a museum object that is original, unique or existing in nature. Objective authenticity can be tangible (e.g. buildings and furniture) but also intangible (e.g. social practices and rituals). This means that human behaviour and habits can also be considered objectively authentic if they are historically accurate. Authenticity can also be subjective, which depends on people's perception of how authentic an experience is for them. As museums are switching from an object-based to a visitors-centered perspective, subjective authenticity is becoming increasingly important. Digital replicas, places, and also living organisms can be considered authentic depending on how they are presented and perceived, and whether the narrative is relevant and meaningful to the public.

In general, I define **Entertainment** as a pleasant experience that happens when one or more external stimulus (e.g. a theatre play, a movie) holds someone's attention. Differently from engagement, entertainment does not need to be educational and focuses instead on a more 'recreational' experience. Theatre performances have been already successfully used as form of entertainment in museums, while games holds an incredible potential to offer narratives that are more immersive and engaging.

I then explored how authenticity and entertainment relate to visitors' satisfaction. Thus, I argued that visitors have **satisfying experiences** as a result of the total museum experience, so whether visitors felt achieved and/or acquired new knowledge; whether the narrative was relevant, enjoyable and clearly communicated to the public; and whether visitors felt involved.

Finally, I discussed *what leads to authentic and entertaining experiences*. Authenticity and entertainment are both very subjective and influenced by personal feelings. Thus, museum experiences should be relevant to the public, connect with their interests, their personal experiences, and answer their needs and expectations. Participatory practices involve visitors directly in the design process. Therefore, through participation museum can understand their visitors, what is relevant to them. Via participation museums can design experiences that hold visitors' attention.

In the next two chapters (Chapter 3 and 4), I suggest **games**-based activities as

a participatory practice to inform the design of interactive visitors' experiences. I choose games because they have a key role in contemporary society and are played by a wide range of people (Section 1.1.2). Moreover, games facilitate communication and strengthen positive skills such as creativity and problem solving (Section 1.1). Finally, game-play and game-making are entertaining activities on their own, so they can keep participants motivated and engaged. In particular, in the next chapter (Chapter 3), I focus on gameful experiences as a mean to empower museum professionals and facilitate the implementation of interactive experiences.

Chapter 3

Towards a Gameful Museum

The vast majority of museums are embracing digital technologies as a way to drive visits and remain relevant, yet they are still struggling to re-think their exhibitions and design interactive experiences. Old reservations about participation and digital technologies (Tallon and Walker, 2008) are still holding strong, particularly in historical museums. For example, DiMEA (se Chapter 2) confirmed that museum professionals are still worried about digital technologies distracting visitors from the real artefacts (Tallon and Walker, 2008).

Museums professionals are struggling to detach themselves from a traditional approach and involve visitors in the design process, so they are usually the main barrier to participation (Lewis, 2014). I was recently talking with the main curator of a major history museum, I was surprised to hear his saying he did not see the point of involving the visitors in the design process. Moreover, museum professionals often lack experience with both digital technologies and participatory practices, a lack that translates in pre-conceptions and skepticism (Maye et al., 2014). In particular, heritage professionals are often relegated to the role of informant and not directly involved in the design of interactive experiences (Ciolfi et al., 2015).

When I brought the storytelling game Tell-A-Dyrham-Tale (De Angeli and O'Neill, 2016) to a property of the National Trust, the staff was initially sceptical. However, after playing the game, their attitude completely changed. It was clear that they never experienced this kind of gameful activity in their museum before, but as they played the game, they understood how it could benefit their visitors. In the same way, museum professionals could be hesitant to use digital technologies simply because they are not able to envision how interactive solutions such as games could work in their institution.

In this chapter I investigate whether gameful experiences can empower museum preconceptions and facilitate the implementation of interactive exhibitions. Co-design activities such as sketching, scenario building, and storyboarding has been successfully deployed to support heritage professionals with the design of interactive experiences (Ciolfi et al., 2015). In this chapter I am investigating how game playing and making can serve a similar purpose. In the first case, I played a game with museum professionals to facilitate communication between members of staff and to support the design of a new interactive narrative (Section 3.2). In the second case, I organized a two-days game jam during which museum professionals were making

games to strength positive skills such as perseverance and creativity, while learning how to use a series of digital technologies (Section 3.3). Finally, I discuss my main findings, current limitations and future implementations (Section 3.4).

3.1. The Museum Struggle in the Digital Age

A museum is *a non-profit, permanent institution in the service of society* (Murphy, 2007). That is, museums need to serve society, to *communicate and exhibit the tangible and intangible heritage of humanity and its environment for the purposes of education, study and enjoyment* (Murphy, 2007). However, museums also need to maintain their own identity and most of them still consider preservation and education their key missions (Murphy, 2007). In particular, historical museums and art galleries tend to be more objects and curators-centered. Curators are used to choose the objects to display and to present them as they are, detached from *human intent* (Evans et al., 2002). In the last 15 years, museum started to embrace the idea that there is "no single authentic voice" (Evans et al., 2002, p. 53) and that visitors maybe asking for a deeper and more pro-active experience than the one offered by traditional museum exhibitions (Hargrove, 2003). Museums have been moving towards a visitor-centered approach where visitors themselves create meaning (Samis and Michaelson, 2017), but at a different pace. As my experience working with museums during the last 10 years suggests, historical museums are the institutions moving slower towards a visitor-centered approach, while science centres tend to be more dynamic and flexible. This is mostly due to the strong curator-centered tradition of historical sites where curators are often still resisting or struggling to adapt (Samis and Michaelson, 2017). However, it is becoming fundamental for museums to connect with the public in order to share knowledge in a way that is both relevant and appealing and ultimately to drive visits (Simon, 2016)

But how can historical properties still be relevant in a digital society rich of competitors for our education and leisure time? Since digital entertainment and games acquired a key role in contemporary society (Section 3.3.1), many believe technology should be included in exhibitions in order to attract new audience, educate and engage the public (Maye et al., 2014), However, the introduction of digital applications in the museum field is still very limited. There are many reasons for that. First, museums are struggling to balance utilitarian purposes such as education with the necessity of offering entertaining experiences, worried of focusing too much in entertainment, becoming more entertainment parks and losing their museum status. Then, a good number of museum professionals lack the technical knowledge or even the experience to design new interactive experiences (Maye et al., 2014). Not every museum has access to personnel with technical skills (Maye et al., 2014). This is particularly true for small and medium museums with limited resources, and in general for historical museums. Thus, museum professionals might not know which technologies are available and how to implements them (Maye et al., 2014). This lack of direct experience is often the cause of pre-conceptions, skepticism, and difficulty in the design of new interactive

experiences such as games (Maye et al., 2014). For example, a couple of years ago I was visiting a small history museum in Somerset, UK. Following the trend of QRCodes, they were advertising a mobile application with which visitors could scan QRCodes around the museums and gain additional information regarding some of the artefacts. QRCodes are relatively simple to use and maintain, so represent a good resource for museums with low income. However, the application was poorly implemented. QRCodes were hanged in uncomfortable locations and were sometimes impossible to reach. Even when they were accessible, the application would simply offer a digital label with basic information such as material and year of construction of the object.

Museum professionals usually try to overcome their lack of direct experience by taking inspiration from other museums or from a variety of media sources (Maye et al., 2014). But this requires time, effort and possibly financial resources. Flexible exhibitions are another option, as curators display authentic content, but the exhibition changes according to public interest (Nielsen, 2015). This means that elements such as objects and labels are continuously changing in response to the visitors' behaviours, for example if they are looking more at one display instead of another (De Angeli et al., 2015). Although the changing display could allow visitors to approach stories in different ways, this process of perpetual change can easily compromise the narrative and also requires a large amount of funding (Nielsen, 2015). In alternative, museums can hire an external company, but that would require economical resources and the museum would loose some control over the project (Maye et al., 2014). More often, museums organize focus groups bringing together curators, educators and sometimes even docents (Ferris et al., 2004; Taheri and Jafari, 2012). Similarly to our two case studies, those focus groups facilitate the design of a new interactive exhibition. Differently, focus groups usually involve a series of scenarios and visitors personas as stimuli for the design process (Ferris et al., 2004), a method that does not teach new technical skills nor provide direct experience with interactive applications such as games. Instead, our two studies involved museum professionals directly with playing and making games.

3.2. Museums Playing Games: Towards New Narratives

Storytelling is a fundamental aspect of human nature (Juul, 2001). Of course, that does not mean that everything is and should be communicated through narrative, but that storytelling is universal, used by everybody for a variety of reasons (Juul, 2001). We tell stories, listen, and understand each other (Juul, 2001). Stories help to connect with other people and to make sense of other cultures (Juul, 2001).

A good narrative can fulfil the need of sharing knowledge as well as to engage and connect with others, thus to communicate in a more relevant way (Juul, 2001). As such, narratives are useful to modify and expand people's perspective and reduce conflict (Juul, 2001). Storytelling is also used to stimulate curiosity, to engage, which is why "storytelling is at the heart of what many museums do"

(Johnsson, 2006), especially in contemporary museums where artefacts are not standalone entities detached form human intent (Evans et al., 2002).

Narrative is also a key aspect for successful games (Beale and Villeneuve, 2011). Games can simulate real life contexts, helping players to immerse themselves into a narrative and to conceptualize design actions (Brandt, 2006; Vaajakallio and Mattelmäki, 2014). Therefore, I created 1001 Dyrham Tales, a storytelling game to facilitate the design of new interactive narratives, support communication and creativity (Muller et al., 1994).

3.2.1. 1001-Dyrham-Tales

Dyrham Park is a late 17th Century country house in an ancient deer park located between Bath and Bristol. William Blathwayt, secretary of state to King William III, started its construction in 1692. The property offers a range of tours and walks to explore the park, the garden and the house, as well as special events during the holidays such as crafts workshops for Halloween and Easter[13]. They also have both permanent and temporary exhibitions to display the story of Mr. Blathwayt, his family and the property. While the exhibitions do not usually involve digital technologies, recently the curators started planning to introduce new technologies such as an interactive narrative to tell the story of the trip that Blathwayt's sons did around Europe between 1704-1708.

The narrative unfolds according to how visitors interacted with objects in the Grand Hall of Dyrham Park. The hall is dense with artefacts and usually visitors walk through the room without paying much attention. By telling the story through the artefacts, we wanted to re-connect the objects with the story of their owners, helping visitors to relate with Blathwayt and his family. The interactive narrative involved four objects in total and users could select any object just by looking at it: (1) a painting of William II, older son of Mr Blathwayt; (2) a painting of John, younger son of Mr Blathwayt; (3) a painting of a harbour; and (4) a fireplace. If the visitor looked at the harbour, then the narrative would focus on details of the travel, while William's painting moved the narrative towards his perspective. John's painting will center the story on the younger son. Finally, the fireplace represented Dyrham Park and Mr Blathwayt who stayed home and kept constant correspondence with his sons.

The children wrote many letters to their father during the four years trip around Europe. Most of those letters were kept, so we had plenty of material to work with. Each letter contained different information, including expenses, random encounters, and details of their travel. The museum could not possibly deliver every bit of information. The curators had to decide which content to include in the interactive narrative, but also how to connect the different bits of information to deliver considering that we were designing a non-linear narrative that could take any direction depending on how visitors interacted with the objects in the room.

[13] *https://www.nationaltrust.org.uk/dyrham-park*

I developed *1001-Dyrham-Tales* (1001DT), a storytelling game, in order to facilitate the design of this non-liner interactive narrative and to test how the narrative could unfold. This game was developed drawing from the experience with *Tell-A-Dyrham-Tale* (TADT), a similar storytelling game described in Chapter 4 and designed to engage visitors at Dyrham Park. The design of TADT was finalized through a series of pilot tests. 1001DT was then implemented in a similar fashion but with a different purpose. While TADT was ultimately deployed in Dyrham Park to collect information from the visitors and inform the design of the interactive narrative, 1001DT was used to empower the staff at Dyrham Park and facilitate communication for the design of the new interactive narrative.

Like with TADT and with other storytelling games, the purpose of 1001DT was to tell a good story. The stories were told using a set of cards (see Figure 3). 1001DT included 13 cards (Table 3) and a central board (see Figure 4). Each card contained a bit of information from the letters and a symbol. There were 4 symbols in total: (1) a horse to represent William II Blathwayt, (2) a harpsichord for John Blathwayt, (3) a carriage for the trip, and (4) a fireplace for Mr Blathwayt. The board included one rectangular space on the left (area 1), connected to additional spaces on the right (area 2). Players played by placing their story cards over this board.

Figure 3: Cards of the game 1001 Dyrham Tales. This picture illustrated one example per topic (John, William II, travel and Mr. Blathwayt). Each topic has a different symbol, e.g. a horse for William II.

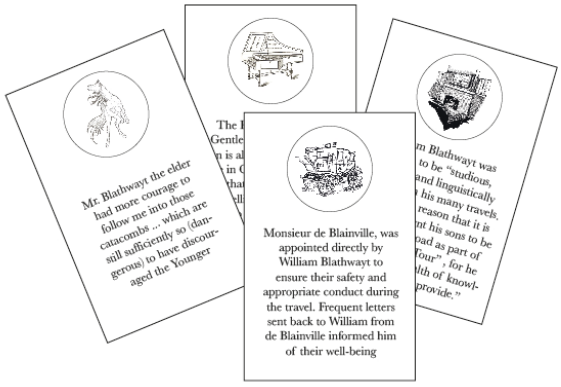


Figure 4: Central Board of 1001 Dyrham Tales with areas 1 and 2.

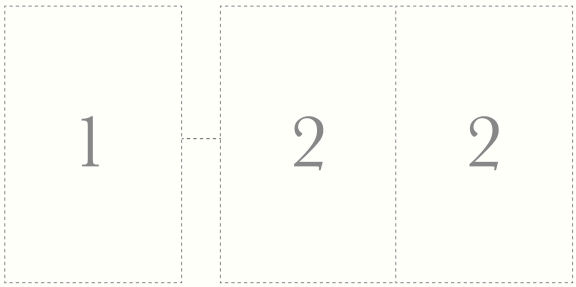


Table 3: Topic, symbol and text for each of the 13 game cards of 1001DT

Topic	Symbol	Text
William II	Harpsichord	Mr. Blathwayt the elder had more courage to follow me into those catacombs ... which are still sufficiently so (dangerous) to have discouraged the Younger
William II	Harpsichord	William's eldest son, William II, was by most accounts the lesser known of the two Blathwayt brothers, having no renown for his musical abilities or intelligence
William II	Harpsichord	For what William II lacked in these musical ability or intelligence, he made up for in honor, and a strong sense of adventure
William II	Harpsichord	In 1706 Marquis d'Arzelliers wrote to William, noting "The Gentleman, your elder Son, has all the sentiments of a man of honor"
John	Horse	The Reputation of the Gentleman your younger son is already so considerable in Geneva ... So much so that M. The Marquis d'Arzelliers has proposed to me to hold this winter a little concert of music in our grand salon
John	Horse	The Gentleman your Younger Son, I am persuaded that he will succeed in anything that he wishes to undertake; but it is necessary that he should be obedient; having a little too Good an opinion of his capability
John	Horse	As for The Italian, Mr. Blathwayt the Younger is sufficiently advanced in it… without very much aid from the Dictionary. As for the Elder, he has not yet made sufficient progress…
John	Horse	William Blathwayt's younger son, John, was truly a man of many talents, so much so that his intelligence and musical prowess often preceded him. During the trip, he was admired for ability with both the Organ and the Harpsichord
Trip	Carriage	The Sons' education was strictly maintained. In Geneva, De Blainville writes to William Blathwayt that "the Riding School, the Fencing School, the Dancing, the Italian master... the Lectures in History, Politics, and Moral philosophy provide their ordinary occupations
Trip	Carriage	Monsieur de Blainville was appointed directly by William Blathwayt to ensure their safety and appropriate conduct during the travel. Frequent letters sent back to William from de Blainville informed him of their well-being
Mr Blathwayt	Fireplace	William Blathwayt was known to be "studious, cultured and linguistically adept" from his many travels. It is for this reason that it is believed he sent his sons to be educated abroad as part of "The Grand Tour", for he knew of the wealth of knowledge it would provide."
Mr Blathwayt	Fireplace	William did not neglect his role as a father during this time (the travel): "when they have time, they should apply themselves to Writing and to Arithmetic, in order to perfect themselves as much as they are able"
Mr Blathwayt	Fireplace	William Blathwayt was really well known in Europe. Even the Prince Royal [Frederick III 1688-1713] straightway recognized the Gentlemen Blathwayt, and spoke much with us about their father

3.2.2. Participants

The game session brought together 3 players: 2 curators of the NT and 1 of the volunteers at Dyrham Park. The two curators were involved in the design of the new visitors' experience. The volunteer not only had experience with visitors but was also an expert of Mr Blathwayt's sons travel around Europe.

3.2.3. Methodology

1001DT takes inspiration not only from classical storytelling games but also from *directed storytelling*. Directed storytelling is a design approach that uses prompts to invite participants to tell compelling stories (Evenson, 2006). Prompts

can be for example photos. The stories are then analysed to find patterns and contribute to design decisions. Similarly, 1001DT uses card games as prompt to invite museum professionals to tell compelling stories and inform the design of a new narrative. However, directed storytelling is usually deployed to collect personal stories, past experiences. Instead, 1001DT is a tool that facilitates the creation of new narratives.

I run the game session in one of the NT offices at Dyrham Park. The session lasted one hour in total: participants played for about 30 minutes and at the end of the game I interviewed the players together for additional 30 minutes. At the beginning of the game, I explained the game rules and then equally distribute the game cards among the players. Then, I placed a random card in area 1. This card would be the intro of the story.

Then, in turn each player could decide if s/he wanted to add a card in area 2 to continue the story, or pass. If they decided to play a card, they could place it in area 2 and tell the story. Participants drew a new card every time they played one. Thus, the game master would decide which story was more interesting and declare a winner for the round. The players could argue the decision by explaining why they though their story was better instead. The players could also tell us if there was any missing information that they would like to play.

Each card was valued 1 point. If a participant played a card with the same symbol as the card placed by the game master, then s/he could gain 1 point and keep 1 card as placeholder. If they played different symbols, then they gained 2 points and thus kept 2 cards. This was meant to stimulate players' creativity and compel them to connect different topics. The game finished once all the cards were played. At the end of the game, we counted the points and declared the winner the player that had scored more. Then, we discussed the content of the cards and the stories told during the game. In particular, I asked whether any information was missing, unclear or wrong. Both the game session and the interview were audio-recorded using QuickTime and MacBook Pro internal microphone.

3.2.4. Data Analysis

An Excel file with two sheets was created. The cards used were transcribed into the first sheet named "Stories" in the order they were use: the first column included the content of the card played in area 1; the second column listed the corresponding cards played in area 2; the third column reported feedbacks or comments from the players related to the specific card or story. Thus, I familiarized myself with the audio-recording and reviewing the transcripts, I then added key points from the interview into the second Excel sheet named "Interview". The transcripts were analysed and organized into four thematic groups: humanize, empathize, system and women role.

3.2.5. Findings

The game session was effective in facilitating the design of a new narrative. Through the game, the staff could experience, reflect and discuss the narrative, highlighting whether we were missing or misinterpreting bits of information. The game stimulated discussion around four main topics: empathy, sympathy, system requirements and women role.

Empathy

The museum was particularly keen for the visitors to identify with Blathwayt and his sons, to see them as human beings, otherwise visitors are just "looking at those paintings (…) and (they) just think '(it is) some guy from the past', then those letters really give you a rich character" (participant #1). The act of 'feeling into' someone else's being, the awareness of another person experiences and feelings is defined as empathy (Hoffman, 2000; Lipps, 1907).

Aspects of the travel could bring characters' humanity 'alive'. Facts related to the tour could be easily related to the characters. For example, during the 4 years his sons were travelling, Mr Blathwayt always asked for detailed reports, related to their education, how much they spent and how much they needed for expenses. These reports draw a picture of the brothers every day life but also of Mr Blathwayt as a caring father and a strong leader. The museum conserves documents from the construction of the house at Dyrham Park and they confirm the same attention to detail and strict control Mr Blathwayt had with managing his sons' travel.

The game also stimulates a conversation about the Blathwayt brothers, their character and the relationship between each other. While the letters unfortunately do not present a clear picture of their personal relationship, they provide clues to understand their characters. For example, John was very smart and talented but maybe too self-confident. William II was more socially awkward, was a slower learner and he was initially scared of horses.

The curators were keen to present the two brothers as humans, with their strengths and weakness. Therefore, they suggested we should add also less positive account of the two brothers in the narrative. For instance, we realized we were "over-play(ing) the good side of William the II" (participant #3). In other words, we were presenting just John's positive attributes while his character had also less positive sides (e.g. he was scared of horses and socially awkward).

Sympathy

By providing a good understand how Mr Blathwayt and his sons lived, the narrative can also draw parallel with our own life today. In this way, we do not just view Mr Blathwayt and his sons as humans, we also connect with them at a deeper emotional level. For example, the narrative could give "you the opportunity as visitor to imagine if it was your children (…). Lots of children to go on travel (…). We can

email, we can Skype, we can keep in contact (…)" (participant #1). There are universal topics that can be linked to our lives today, like the need for money and for education. Thus, we can feel what Mr Blathwayt felt when his sons were travelling. Moreover, details about the travel could not only useful to contextualize the story, to map out the travel around Europe, but also to describe the main issues Mr Blathwayt's sons encountered, such as bad weather and scared horses, and this can help the players to sympathize with the characters.

System Requirements

The players also gained a better understanding of how the narrative should be delivered, identifying possible issues before the final design of the system. For example, participants discussed who should tell the story to the public: Mr Blathwayt, his sons or the French tutor who accompany the children during the trip? The sons wrote just few very short letters to their father, so most of the conversation was between Mr Blathwayt and his sons' tutor. Therefore, the curators agreed that there should be two narrators - Mr Blathwayt and the French tutor – to re-create the original conversation between father and tutor.

Women's Role

The game also sparkle some curiosity about women of the Blathwayt family and their role in society. The letters reference Ms Blathwayt twice. She is not William II and John' mother but their sister. Mr Blathwayt's wife was already dead at the time the sons left for the grand tour. Mr Blathwayt's died very young of childbirth, which was probably the same cause for her mother death. She was very young, probably 12 years old, when her brothers left for Europe, which is maybe the reason why she did not join them on the trip as well. However, the curator suggested that even if she was older, she would not have travelled either. She would have stayed home instead. Nonetheless, from the letters we infer that Ms Blathwayt was well regarded and maybe even had some influence over her father as she was asked to intervene in a delicate matter.

3.3. Museums Making Games: Promote Interactivity

In our second study I involved museum professionals in a game jam, an event during which they had to develop different kind of games. The main purpose of this workshop was to help museum professionals overcome possible preconceptions and facilitate the design of new interactive experienced in their institutions. This activity also provided me with a better understanding of how museum professionals perceive and use games. Thus, I organized a game jam because:

(1) Game jams are a powerful educational tool to teach new skills where participants learn through practical experience (Fowler et al., 2013). By attending

the game jam, museum professionals learned a new set of tools, as well as when and how to use them.

(2) Game jams support not only creative design and prototyping but also collaboration (Locke et al., 2015; Musil et al., 2010). Thus, game jam can facilitate communication within an institution and co-design of new visitors' experiences.

(3) Game jams have been recently introduced in few museums but their use is still limited. Institutions have used game jams mainly as an educational tool (e.g. JamToday in Milan[14]). By attending a game jam, museum professionals could understand how those events can benefit their own institution.

Figure 5: Interior of the Natural History and Science Museum in Porto

3.3.1. Settings

In 2017 I organized the GameLab workshop at the Natural History and Science Museum in Porto together with other international speakers and professionals in the museum field. The workshop was organized before the conference of the European Network of Science Centres and Museums (ECSITE)[15] with the main purpose of providing museum professionals with new skills to produce and deliver games.

The workshop lasted 2 days in total. At the beginning of the first day, we presented a series of case studies to showcase which tools can be used to develop games even with limited technical skills. In particular, we described tools such as Twine and NFC Tags, demonstrating how they could be used to develop a simple interactive experience in a museum.

After that, participants visited the museum to learn more about its collection. Thus, participants were divided into teams to develop a series of games based on the museum collection, testing different technologies and concepts. They were completely free to be creative and experiment, without external pressure but with the support of a team of facilitators, including myself.

[14] *https://jamtodaymilano.wordpress.com/*
[15] *http://www.ecsite.eu/annual-conference*

3.3.2. Methodology

I developed a pre and post survey using Google from. The surveys were designed to investigate how museum professionals' perceive and use games, but also to understand whether the workshop facilitated the development of games.

I send the pre-survey the day before the workshop and remind participants to fill it out at the beginning of day 1. I shared the post survey at the end of day 2, asking participants to fill out the form before leaving.

The **pre-survey** included basic questions, such as email and organization, followed by a question exploring motivation: Why are you attending this workshop? This was a multiple answers question which included the open option 'Other'. The survey then listed a series of game-related questions:

- *What is your definition of game?* This was an open-ended question designed to record participants' definition of games before the workshop
- *Does your institution offer game?* This was a multiple-choice question. Participants could select 'Yes', 'No' or 'Just working on our first game'. Participants were then directed to a specific section of the survey according to their selection.
- *If yes, which kind of games?* Multiple-choice question listing different types of games (e.g. mobile game and outdoor game) and the option 'Other'. Participants could also include an example of a game they were offering.
- *If yes, why?* Multiple-choice question including a list of motivations (e.g. educate visitors and promote temporary exhibition) and the option 'Other'. Participant could also add the example of a game that was particularly successful or not.
- *If not, would your organization like to offer a game?* Multiple-choice question with the following options: yes, no, maybe. Participants were redirected according to their selection.
- If their answer to the previous question were 'No' then participants would directly submit the survey. For any other answer (i.e. Yes and Maybe), they were instead sent to the last section of the survey that included two multiple choices questions: *Which kind of game?* and *Why*? that were listing the same options as the previous questions "If yes, which kind of games?" and "If yes, why?".

The **post-survey** was shorter (i.e. had less question that the pre-survey) but included more open-ended questions designed to evaluate the impact the workshop had on the participants:

- The survey asked again for a *definition of game* to explore whether the workshop changed the way participants perceived games. This was an open-ended question
- *What did you like about the workshop?* This was an open-ended question.

- *What did you dislike about the workshop?* This was an open-ended question.
- *Do you plan to use any of the tools we illustrated during the workshop?* This was the only multiple-choice question, where participants could simply select the tools they learned during the workshop that they were planning to deploy in their institution
- *Did the workshop influence in any way how you design/plan museum experiences? If yes, how?* This was an open-ended question.

3.3.3. Data Analysis

Survey results were then reviewed and organized into an Excel file following four themes: motivation to attend the event, motivation to develop games, definition of games, and types of games. These thematic groups provided a better understanding on how museum professional perceive and use games, but also why they offer or wish to offer games. Thus, via game making we aimed to empower museum professionals but also to better understand them, their point of view and their needs. I was also hoping to explore whether the workshop had some form of impact. For example, I have asked for their definition of game before and after. I have also asked whether they were planning to use any of the tools illustrated during the workshop and if they rethinking the way they design museum experiences.

3.3.4. Participants

The workshop had 14 participants from museums and other cultural organizations interested in using games. Before and after the workshop, I asked participants to fill out an online survey. Participation to the workshop was voluntary and filling out the questionnaire was also optional. As a result 8 out of 14 filled out the pre-survey and 6 out of those 8 completed the post-survey as well. The sample is small and I could compare the impact of the workshop with 6 participants but this study still provided some insights into museum professionals' perception and usage of games.

3.3.5. Findings

Participants "really really really enjoyed" (Participant #2) the game jam. Participants were particularly impressed by the diversity of approaches and games presented: they liked "the diversity of approaches" (#1), "the wide range of examples" (participant #3) and the "diversity of games presented". They also enjoyed the possibility of having hands-on experiences. And a participant highlighted how working closely together with other museum professionals for 2 days was an incredible social experience that allowed her to increase her network and to learn "different ways of working in action" form others.

Moreover, the workshop met participants' expectations. For example, 4 participants wished to have a good time and meet new people, and after the

workshop they confirmed that it was “easy to meet people and really make a connection” (#2). This study also confirmed that museum professionals often like to take inspiration from other institutions (see Maye et al., 2014). Indeed, 8 participants attended the workshop mainly to discover how other people used games and 7 participants to learn how to make a game. In general, participants were personally interested in games 5, while a minority (i.e. 3 participants out of 8) attended because their institution was interested in games. Finally, the workshop improved our understanding of how museum professionals perceive games and provided museum professionals with a broader idea of what games are or should be.

Why games? Although participants were generally very interested in games, 4 out of 8 was not currently offering games in their institutions but was thinking about developing their first games in order to engage visitors. 2 out of 8 participants used games to connect with visitors and younger audience. Similarly, 2 out of 8 participants who were already offering games confirmed that games were used mainly to engage with visitors. Contrarily to participants who were thinking of developing one, already published games were not considered as a tool to relate with young audience or to understand visitors’ needs. Instead, 1 participant explained how games were also published to promote a new exhibition or to stimulate reflection.

Which games? The majority of the games already published were tabletop, computer and role games, with some puzzle, educative and outdoor activity. And while none of our participants was offering a mobile game, 3 out of 8 participants was considering of developing a mobile game. 2 out of 8 participants were interested in designing a puzzle, multiplayer or outdoor game, which reflects trends in game industry where mobile games are becoming increasingly popular (Egenfeldt-Nielsen et al., 2016; UKIE, 2017). After the workshop, 3 out of 6 participants wanted to use NFC tags, 4 out 6 wanted to design escape rooms.

What is a game? 4 out of 8 participants mostly considered games as a fun and engaging activity to do. 2 out of 8 participants also consider games as an educative tool and just 1 thought that games could enrich visitors’ experience. 3 out of 8 participants stressed out that games have rules, 2 that there are elements of challenge and competition, and 1 participant recalled that games have goals. The definition of game did not dramatically change after the game jam, but 3 out of 6 participants added the word “fun” to describe what a game is, which could indicate an increased awareness of the entertaining dimension of games. Moreover, 2 out of 6 participants thought that the workshop changed the way they conceive visitors’ experiences.

3.4. Discussion

We are living in what Zimmerman calls the Ludic Century, where people

spend their leisure time playing with games or game-like activities (Zimmerman, 2015). Human beings have always played games - even in museums – but "digital technologies have given games a new relevance" (Zimmerman, 2015, p. 19). However, many museums are still sceptical or unfamiliar regarding digital technologies (Zimmerman, 2015). This is mainly due to the lack of both technical skills and direct experience with gameful and digital experiences.

By playing and making museum games, professionals gain direct experience with games, learn new skills and most importantly **overcome their fears and prejudices** towards technology. By playing and making games, museum professionals can acquire or enhance **traits typical of gamers** (McGonigal, 2015). For example, through 1001-Dyrham-Tales participants took pleasure in completing tasks, identify issues, share ideas and found creative solutions. Through game making, participants gained direct experience as game developers, learning new tools but also when and how to use them.

After the workshop, participants demonstrated interested in using the new learned tools in their museums. 2 museum professionals even contacted us afterwards to ask for additional guidance as they were developing new interactive experiences for their institutions. Moreover, participants defined games as a pedagogical tool but also as a pleasant and **fun activity.** Apparently, the workshop enhanced the idea that games final goal should always be to make an experience more enjoyable (Walz and Deterding, 2015). This may seem obvious, however when game-elements and experiences are developed with purpose rather than just entertainment, the entertaining dimension is often neglected. That is, museums tend to focus on the educational outcome missing the opportunity to also entertain.

I also acknowledge that our studies had **limitations**. For example, 1001-Dyrham-Tales was played with a small sample (i.e. 3 museum professionals). Moreover, participants of GameLab were already interested in games, while we should also target those professional that hardly think about games. However, the interview at the end of 1001-Dyrham-Tales provided more in depth information. At the end, the study accomplished its scope, which was to empower the curators of Dyrham Park and facilitate their design of a new interactive narrative. GameLab also involved a small sample: 8 participants of which 6 answered also the post-survey. Moreover, this time I collected data only through surveys and I did not carried out interviews. However, the survey included explicit open-ended questions that are proven to improve response quality (Manfreda et al., 2003; Smyth et al., 2009). This study had two scopes: understand museum professionals' perspective of games and facilitate the development of games. The open-ended questions provided additional data regarding participants' perspective on games. GameLab still accomplished this, even if in a small scale.

Finally, I did not run the studies with the same participants in multiple occasions, so I could not access long-term benefits such as increase levels of persistency, increase creativity and outcomes. Nonetheless, those initial studies served as a starting point and laid the ground to organize **other game-based workshops** with museum professionals. For example, after playing 1001-Dyrham-

Tales, one of the curators asked us to organize additional workshops with other curators of the National Trust. I also published a template of the game, which can be reused for different purposes (https://drive.google.com/drive/folders/1YQaM1svqulqyu-vJiSC0fmgRZ5e7AuFg?usp=sharing). The template includes blank cards, different boards to accommodate different number of players, and the game rules. Museums can download it for free and write their own content in the cards. Furthermore, I am collaborating with a new game-making workshop during ECSITE 2018 and I am planning to use survey as well as other methods to collect data including direct observation. Hopefully, this will engage more museum professionals and provide additional data.

3.5. Summary

Digital technologies are rapidly evolving and are now part of our everyday lives. Technology is also offering new opportunities to museums to offer entertaining experiences to their visitors. On one side, visitors are asking for more interactive experiences. On the other side, museums hold reservations about digital technologies and games. Indeed, museum professionals are often the main barrier to gameful experiences.

Museum professionals' scepticism is mainly due to a lack of technical skills and a long-standing experience with the design of passive object-centered exhibitions. In order to overcome museum professionals' fears and prejudices, I run two workshops. In the first case, museum professionals from the National Trust UK played 1001-Dyrham-Tales, a storytelling game. In the second one, museum professionals from different institutions attended a game jam during which they made a series of games.

Through those gameful experiences, museum professionals gained experience as game players and developers. They strengthen personal skills such as creativity, determination, capacity of overcoming obstacles and collaboration. They also learned how and when to use new digital tools. The game-play session facilitated the design of new interactive narrative. The game jam allowed museum professionals to gain experiences and confidence with digital tools. It also provided me with a better understanding on how museum professionals perceive and use games.

In this chapter, I successfully used gameful activities to empower museum professionals. In the next chapter, I use gameful experiences to engage with the public instead, collecting data and providing knowledge to inform the design of new museum experiences.

Chapter 4

Research through Games: Informing the Design of Museum Experiences in the Digital Age

The rapid evolution of highly interactive artefacts is encouraging researchers and designers to modify existing methods or to develop new approaches. In line with Houtari and Hamari's (Huotari and Hamari, 2012) emphasis on gameful experiences to support users' value creation, I propose *Research through Games* (RtG) as a game-based collaborative research method. RtG also draws from a range of game and design research methods (Section 4.1). In particular, inspired by the concept of *Research through Design* introduced by Frayling (1994) and expanded more recently by Frankel et al. (2010) and Zimmerman et al. (2007), I propose that games are not just gameful experiences (Huotari and Hamari, 2012) but their design can also provide knowledge to inform the museum context. The museum context is an ideal testbed for the RtG approach because it involves visitors directly in the design process, informing the design of new experiences intended to be both entertaining and meaningful for museum and visitors.

In the previous chapter (Chapter 3), I introduce the use of game-based activities as a method to facilitate museum professionals with the design of interactive experiences. In this chapter, I present game-based activities as a research method to collect data about and from visitors. I first establish the basis for the definition of RtG by discussing the concepts of design research (Section 4.1) and game research (Section 4.2), focusing on how they relate to each other and how games can be used to support design and research (Section 4.3). Next, I run two studies to investigate how gameful experiences can support the design interactive user experiences that are both *meaningful* and *entertaining*. In the first study, I gathered data from users' *playing* Tell-A-Dyrham-Tale, a storytelling card game (Section 4.4). Then I describe how data was collected from participants *making games* during GameTale (GT), a two-day Game Jam (GJ). Finally, I analyse findings, summarise how RtG can inform the design of interactive experiences (Section 4.6.1) and present recommendations on how to set up, implement and document RtG studies (Section 4.6.2).

4.1. The Basis of Research through Games

RtG is a research methodology, that is a systematic search for knowledge, an investigation to gain new information and inform solutions to problems (Kothari, 2004; Rajasekar et al., 2006). For example, through research I gain new insights into a phenomenon, understand the characteristics of a particular event or individual, determine frequency of something, or to verify causal relationships between variables (Kothari, 2004). Therefore, research starts by identifying a topic or problem, and proceeds by collecting data to find a solution (Kumar, 2014; Rajasekar et al., 2006). Information is usually collected from a 'study population', meaning a study of individuals, groups and communities, and refers to a 'subject area', that is a problem, program or phenomenon (Kumar, 2014).

RtG takes inspiration from both game and design research (Figure 6). Research and design are different concepts, with different orientations and outcomes (Stappers and Giaccardi, 2013). While design and research share a similar purpose, which is to create something new (Stappers and Giaccardi, 2013), research is theoretical and aims to produce general knowledge that can be applied long-term in other areas. Design is more situated and practical, focusing on the short-term creation of a specific solution. Nonetheless, design processes can involve research activities and research can include the design of prototypes (Stappers and Giaccardi, 2013) (Section 4.1.1).

Research and games are different concepts as well. A game is identified as an activity (i.e. event) or system where players are voluntarily engaged in an artificial conflict defined by rules and resulting in quantifiable outcomes (Abt, 1987; Huotari and Hamari, 2012; Salen and Zimmerman, 2004). However, games have been used for research purposes (Aarseth, 2001) and research can include playing games (Schrier, 2016) (Section 4.1.2)

Figure 6: This schematic illustrates how Design and Game -based research relate to RtG

4.1.1 Design Research

The increasing complexity of social interfaces, designs and products introduces the need for new methods that support not only the design of usable interfaces but also the development of products and services that are desirable, understandable and appropriate. Correspondingly, new methods are needed to better understand audiences, to explore users' needs and to guide design solutions (Tussyadiah, 2014), not only for design but also to ground, inform, inspire and produce the development processes (Zimmerman et al., 2007).

In this context, design may be used as research to gain new knowledge because it is systematic, directed to a goal, and communicable (Frankel and Racine, 2010). Design research is particularly effective when addressing "wicked problems". Rittel and Webber (1973) define wicked problems as a "class of social system problems which are ill-formulated, where the information is confusing, where there are many clients and decision makers with conflicting values, and where the ramifications in the whole system are thoroughly confusing". Most design problems are "wicked" (Buchanan, 1992) and they cannot be addressed with traditional scientific method because the stakeholders have conflicting perspectives, needs and values (Buchanan, 1992; Zimmerman et al., 2010). Thus, societal problems such as sustainability can be considered wicked and may be better suited to a design inquiry approach (Buchanan, 1992; Zimmerman et al., 2010).

Design research has been investigated for the past couple of decades (Michel, 2007) but it is still a growing field and lacks yet an established scope. For Blessing and Chakrabarti (2009), design research is a set of tools to understand and improve designs. For Kultima (Kultima, 2015b), design research is a system to develop and communicate knowledge. Because of the growing interest in design research, researchers are attempting to provide common guidelines and ways to corroborate research contributions. For instance, Zimmerman suggested a set of criteria to assess design research contributions (Zimmerman et al., 2007). First, work should be reproducible. Thus, methods should be justified. Secondly, work must constitute a significant invention, i.e. have novelty. Thirdly, work must be relevant (e.g. for the community) and its relevance must be motivated. Finally, the work must be well-documented and usable.

While Zimmerman's work can help us to assess whether a particular piece of research made a contribution to design research, other researchers have reviewed the field of design research in order to identify common themes (Frankel and Racine, 2010; Frayling, 1994). These studies identified three main types of design: (1) Fundamental or Basic, which addresses fundamental principles of design. (2) Action or Clinical Research, which addresses specific problems and thus goes beyond the individual, helping acquire new knowledge and new understanding. (3) Applied Research, when general problems are investigated and hypotheses drawn from one or more cases, gaining knowledge that is then applied in different settings.

Each of these categories of design research can be investigated through a design research methodology (Frankel and Racine, 2010; Frayling, 1994):

- Basic research is addressed with Research into/about Design. *Research into/about Design* is the easiest to define. It is, for example, historical or aesthetic research about design theory. It helps define design problems.
- Clinical Research is addressed with Research for Design. *Research for Design* is the equivalent of gathering reference material. It is research to enable design and is action-based and practice-led.
- Applied research is addressed with Research through Design. *Research through Design* represents what is being communicated through the design. It is research-oriented design, which is also practice-led, but with reflection: knowledge is derived from practice and also feeds into practice. It creates knowledge but not a solution, instead assisting future designs. Therefore, it focuses on societal change (Zimmerman et al., 2010) and it is user-centered (Gaver, 2012). It is useful for engaging with wicked problems and it fits participatory models such as Experience Design.

These approaches are distinct but not separate. In particular, Research *for* and *through* Design can be used at the same time; and because game research (GR) is strongly based on design-related approaches, these three approaches may also be applied to game research. Game and design research share common ground, however, games maintain their own particular context as they have their own meaning, aesthetic and value (Carter et al., 2014).

4.1.2 Game Research

Game research received official recognition in 2001 with the publication of the inaugural issue of the first peer-reviewed academic journal dedicated to computer game studies (Aarseth, 2001). Since then, game research growth to become a multidisciplinary field addressed by different research communities and published in a growing number of venues (Melcer and Nguyen, 2015). However, the field of game research "is very young, not just in history, but also in average age of its professional participants", publications are often brief, and it is still not a coherent domain but a mix of methods and interests (Aarseth, 2015).

Despite this, Carter et al. (2014) found common topics and conceptualized 4 types of game research within HCI. The first two, ontological and practice, are strictly related to games and their play experience. Thus, researchers have focused directly on the analysis of games and game play, including modes of interaction and game interfaces (e.g. Horn et al., 2012; Jones et al., 2013; Waern et al., 2012), and players' interaction and behaviour (e.g. Ducheneaut et al., 2009; Nacke et al., 2009). This research is carried out using techniques such as direct observation, focus groups, "modding" (i.e. altering original game files), and analysis of pre-existing records (e.g. game manuals) to research games and develop new theories (Lankoski and Bjork, 2015).

The other two types of game research go beyond the study of games *per se*: the operative paradigm analyses how games can be used for a goal; the

epistemological paradigm looks at games as opportunities to research other contexts, gaining knowledge that can be used in other systems. These two paradigms illustrate that researchers are seeking to use games for a goal other than games themselves, and in particular to support and inform other contexts and applications. For example, games have been used by companies to collect data (Kirman et al., 2010), produce knowledge (Schrier, 2016), and facilitate the design of new products (Muller et al., 1994).

Facilitating Data Collection

Games have the ability to support data collection both from and about players (Kirman et al., 2010), which is why games have been successfully used for consumer research. For instance, (Benedek and Miner, 2002) designed a card game to gather data on players' feelings about specific products. Recently, games have been also introduced in the field of survey research (DeVault, 2017). Usually surveys are not intrinsically valuable to their participants. As a consequence, response rates are often low. Games are used to make surveys more engaging, to provide participants with value, and ultimately to motivate users.

This kind of research has been called "*Research through Gaming*" and has been defined as "gaining data from the actions a respondent takes while playing a computer game and the way the respondent plays the game itself" (Adamou, 2011). Research through gaming focuses on computer games and people playing them. Adamou (2011) suggests that games can make market surveys more appealing, but this assumption has been little tested in the field.

A purpose beyond entertaining

Games can be used to gain knowledge from players in order to solve real-world problems and inform other contexts. Currently, there is not a consensual name for this kind of games. Carter et al. (2014) suggests that game research focuses mainly on *games for a purpose*, trying to go beyond games' nature by looking at how they can benefit players for specific purposes including education (e.g. Hämäläinen et al., 2005; Horn et al., 2012), rehabilitation (Boulanger et al., 2013), and social impact (Swain, 2007). Holm Sørensen and Meyer (2007) and Stone (Stone, 2008) reiterate that games with a purpose move beyond entertainment per se and use the term *serious games* to define the genre. Karen Schrier (2016, p. 5) simply uses the term 'knowledge game' to label games that can "potentially enable people to contribute, solve authentic problems, produce new ways of seeing the world and make real-world change".

Games that focus on scientific issues are generally called *Citizen Science Games* (Schrier, 2016). For instance, gaming technologies have been recently deployed for the collection of clinical information, mainly with children (Sinnott et al., 2015) and elders affected by dementia (Morgan, 2016). This is the case of Sea Hero Quest, a game developed to collect data about navigational abilities (Morgan,

2016). The game reached 3 million people around the world[16]. Although these initial studies have been successful and demonstrate the potential of games for data collection, the use of gaming in other fields such as in the healthcare system is still very limited and viewed with caution (Sinnott et al., 2015). Data provided via clinical tests is still considered more reliable, so game will unlikely replace traditional medical tests. Moreover, citizen Science Games focus exclusively on collecting scientific data via game play. Why not use game-based activities to provide knowledge from and for other fields?

Support Design

Game play activities have successfully supported design related research (Brandt, 2006; Vaajakallio and Mattelmäki, 2014), including exploratory design (Johansson and Linde, 2005), product development (Benedek and Miner, 2002), and user-centered research (Brandt and Messeter, 2004; Deen et al., 2014).

For instance, design games are co-design tools used to emphasize play qualities in order to engage with players and support discussion towards shared understandings. Design games support participation through a set of rules and game pieces, and often include elements of competition (Brandt, 2006). In particular, rules establish a common language, allowing designers to engage with multiple stakeholders (Brandt and Messeter, 2004). Rules can also be flexible, open to interpretation (Hannula and Harviainen, 2016), and thus can empower players. Moreover, design games offer a safe context to test experiences and to discuss present and future solutions.

Games have been also used as a design tool to improve the work context (Brandt, 2006), and as an educational tool to build design competence, for instance to teach students how to design for participation (Iversen and Buur, 2002). Games can replicate real life contexts, helping players to understand and conceptualize design actions (Brandt, 2006; Vaajakallio and Mattelmäki, 2014), so scenario-oriented games can create simulations of real situations and adapt to participants' preferences. According to Brandt (Brandt, 2006; Brandt and Messeter, 2004), games stimulate imagination and collaboration and can represent different perspectives, guiding players towards a better understanding of other people.

Moreover, games have been designed specifically to study other games and to drive the creation of other games. For instance, Waern and Back (2015)used role-play games and paper prototypes to better understand gameplay and the core mechanics of specific games. Wetzel et al. (2016) used cards to support designers during the development of mixed reality games. Mueller et al. (2014) developed a series of *Exertion Cards* to support the design of exertion games. Through their study, Mueller et al. (2014) observed how cards can facilitate and orient design by creating common ground, spreading focus among participants and setting all participants at the same level. Other studies corroborate that card games are effective tools to support dialogue and thinking "out of the box" (Hannula and

[16] https://itunes.apple.com/gb/app/sea-hero-quest/id1034383306?mt=8

Harviainen, 2016).

Finally, games can inform the design of a service, with the purpose of either improving an existing service or creating a new one. Service design games do not provide a final design solution but are a platform to facilitate communication by bridging between consumers' needs and providers' capabilities (Hannula and Harviainen, 2016). Thus, service design games are mainly reflection tools, which are entertaining but can also provide designers with new knowledge, for example regarding the stakeholders involved in the activity. Although service design games appear to be useful tools for design research, they are not primarily academic, rather to provide an enjoyable setting to facilitate the design process (Hannula and Harviainen, 2016).

4.2. Defining Research through Games

RtG is a research methodology and as such, it collects information and creates knowledge to solve problems. There are different research methods - tools, procedures, approaches and algorithms - to collect information (Rajasekar et al., 2006). RtG gather data from and about participants through different methods involving game-based experiences. In RtG, participants are directly involved in *making* or *playing* games, becoming co-creators in an engaging, educational and social experience. Since RtG collects information from and about participants, then it can provide a better understanding of what is meaningful and entertaining for them, thus informing future user experiences. Therefore, both research through design (e.g. game jams) and game-based research (e.g. knowledge games) can be considered RtG as long as they use either game play or game design to gain data and inform other contexts.

Games have been proposed already as award or motivational technique to collect data (Adamou, 2011), or as a method to gain knowledge (Schrier, 2016). However, a common established methodology is still missing. Besides, playing a game is only one side of the coin. Researchers such as (Chatham et al., 2013; Deen et al., 2014; Preston et al., 2012) have suggested that game creation could be a valuable research method in disciplines including HCI. In particular, Deen et al. (Deen et al., 2014) introduce the idea of using game jam as a research through design method, particularly with exertion games. According to Deen et al. (Deen et al., 2014), both the design process and artefacts can be used as a case study to explore specific research questions, particularly with younger people.

However, the idea of game jam as a research method is still at an exploratory stage and the published literature consists mainly of short papers such as (Deen et al., 2014) and (Chatham et al., 2013). Moreover, game jams are typically not recorded or documented in a way that enables the HCI and related communities usefully to evaluate game jams as a potential addition to their methodological toolkit (Locke et al., 2015). Game jams are a recent innovation and the little research that has been done in the field is mostly to evaluate a game jam as an event *per se*

(Fowler et al., 2013; Locke et al., 2015). In this section RtG is presented as a research methodology through which gather knowledge from people either playing a game or attending a game jam.

4.2.1. Principles of RtG

A research methodology should include a set of principles and ideas that inform the design of a study (Birks and Mills, 2015). Based on our definition of RtG, I identify the following main principles of RtG (Table 4):

RtG *offers* ***a 'game experience'***. This principle is specific of RtG. Since the method is based on game-based applications, RtG should provide an entertaining game-like experience. (Huotari and Hamari, 2012) suggest that 'gamefulness' could be the unique condition of games. Games have also other non-unique conditions that are necessary in order to identify an activity as game, but they are also true for other experiences (Huotari and Hamari, 2012). For example, rules (Abt, 1987; Salen and Zimmerman, 2004) and conflicting goals (Huotari and Hamari, 2012) are considered central aspect of games. As for game-making, (Kultima, 2015a) defines game jams as "*an accelerated opportunistic game creation event where a game is created in a relatively short timeframe exploring given design constraint(s) and end results are shared publicly"*. Usually game jams have a limited timeframe (e.g. 48 hours), which means participants need to prototype rapidly, and provide a thematic constraint, which means participants cannot develop just any old game. Anybody can participate as a "jammer" although small teams are encouraged.

Data collected should be transparent, reliable and generalizable. The term *transparent* is adapted from well-established research in HCI where good interfaces are transparent as they seemingly 'disappear' and become invisible to the users that can maintain their work 'rhythm' without disruptions (Bardram and Bertelsen, 1995; Holtzblatt et al., 1988). Since RtG aims to be an engaging, game-like experience on its own right, data collection should not disrupt participants' experience. *Reliability* is a broadly established concept in both qualitative and quantitative studies. Reliability relates to *generalizability* as researchers carefully document their techniques so that their data is accessible by others and others can replicate their method (Armstrong et al., 1997).

In order to address a specific issue, RtG should ***balance constraints and freedom***. Constraints are key to directing data collection towards what the researchers are actually interested in investigating. Freedom allows players creativity and self-expression. (Näkki and Koskela-Huotari, 2012; Sanders et al., 2010) suggest that games should leave space for freedom and creativity, particularly in participatory studies where games are used as a support for design. In RtG, therefore, the tension between constraints and freedom must be resolved in a way that provides both effective gameplay, with all the characteristics that demands, and effective data collection.

As a research methodology, RtG should also have a robust and reliable mechanism through which to ***share outcomes*** and inform researchers and

professionals for a variety of contexts.

Table 4: A synthesis of Research through Games principles

Collect information and Produce knowledge	- Offer '*a game*' experience (Collect data by playing/making games) *- Data collection is transparent, reliable and generalizable- Data collection is transparent, reliable and generalizable*
Solve problems and Inform other contexts	- Balance constraints and freedom - Share Outcomes

4.3 Playing Games as a Research Method

In this chapter, I present the first example of RtG in which we collect data as users **play** *Tell-A-Dyrham-Tale* (TADT), a storytelling card game based on the story of William Blathwayt. Mr. Blathwayt was Secretary of State to King William III and founder of Dyrham Park, which is currently property of the UK's National Trust. In 2016, the property received 235,768 visitors (ALVA, 2016).

TADT was designed as an RtG activity with the purpose of informing the design of a new interactive experience in the Great Hall of Dyrham Park. The Great Hall showcase several artefacts including paintings of William Blathwayt and his family, but also objects he once owned, such as a bookcases in the Gran Hall (Figure 7). However, visitors often do not pay much attention to them. The curators wanted to re-connect the objects with their human intent and help visitors to emphasize with Mr. Blathwayt and his family. In other words, they wanted to create a new narrative that could be more relevant and engaging for the visitors.

A good story is the key to a successful interactive experience, including games (Beale and Villeneuve, 2011) and museum tours (Gray, 2014). Storytelling is used to stimulate curiosity, to engage, which is why it "is at the heart of what many museums do" (Johnsson, 2006). DiMEA (see Chapter 2) confirmed that a good narrative is essential for museums but also challenging to achieve. In particular, historical properties such as Dyrham Park are faced with the challenge of connecting a space that is not lived anymore with the people who once lived in the property.

Thus, I asked the curator of Dyrham Park to collate information connected with Blathwayt, Dyrham Park and this bookcase, for example, the books that Blathwayt owned and displayed in the 17th Century. Then, instead of adopting the usual approach of the curator selecting which information to present and which narrative to tell, I have designed TADT to inform new meaningful narratives and answer two main questions: (1) Which bits of narrative are more appealing to visitors? (2) How do visitors perceive different narrative genres?

4.3.1 The Game

TADT was designed as a storytelling games. In classical storytelling games

such as *Once upon a time*, the game cards provide chunks of information through pictures and text and participants tell their own stories using these cards as stimuli. In particular, storytelling card games can support the co-creation of narratives that are historically/scientifically coherent while giving players the opportunity to create their own meaning (Roussou et al., 2015). Each card can provide players with authentic information, e.g. historical or scientific, to guide the co-creation of narratives by the players. But players choose which cards to play and which story to tell. Therefore, storytelling card games could provide us with an understanding of what content and stories players find interesting.

Figure 7: The Great Hall with the bookcases, Dyrham Park

As in other storytelling games such as *Once Upon a Time*, players of *Tell-A-Dyrham-Tale* need to tell a good story in order to win. *Tell-A-Dyrham-Tale* was organized in three phases: (1) The auction phase in which players bid for cards and bought them using game coins. Each card represented characters, places and items connected with the bookcase and Dyrham Park; (2) The storytelling phase in which each player used her set of cards to tell a story; (3) The voting phase in which players voted for the best story.

As Mueller et al. (Mueller et al., 2014) suggested, a game with too many cards can be overwhelming for players. By focusing the narrative around the bookcase, the amount of information was constrained to a set of 32 cards from which the players chose to tell their stories (Appendix A). Each card contained a piece of information from the content collected by the Dyrham Park curator (Table 6). Information was related to the bookcase and also to Blathwayt, his wife and other characters connected with Blathwayt's life.

Figure 8: Tell-A-Dyrham-Tale. The storytelling game Tell-A-Dyrham-Tale with game components including rules, coins and cards

Table 5: Game components - silver coin (front and back), gold coin (front and back), winning tile (front and back), and an example of game card (front and back)

	**Silver coin** Front-back
	**Golden coin** Front-back
	**Winning tile** Front-back
	**Game card** Front-back

One side of the card showed pictorial information while the other side presented a related textual description (Table 5). Both sides of each card showed its title, number and colour code. Each card had one of four colours: (1) Red cards provided historical information; (2) Green cards gave scientific information; (3) Blue cards gave information about the house or furnishings; and (4) Orange cards related to specific books displayed within the bookcase. For instance, card number 1 portrayed William Blathwayt, owner of Dyrham Park and commissioner of the

bookcase. The front of the card showed a portrait of Blathwayt and the back briefly described him. Thus, the cards provided historically accurate information and were used as both content and stimuli to inform the creation of stories by visitors.

The game also involved winning tiles and two types of coins, silver coins that had a value of 1 and gold coins that had a value of 5 (Figure 8) (Table 5). At the beginning of the game, each player had no cards but had a set of silver and gold coins. The coins were used in the first phase of the game, the auction. During the auction a facilitator acted as game master, and after briefly describing the content of all the cards, she sold the cards to the players for the highest bid. Each player bought at least three cards from the game master. After the auction, there was a storytelling phase during which each player told a story using from 3 to 5 cards from the deck of cards she had previously bought. Each player could tell the story in any order and using either of the two sides of the card (i.e. the side with the picture or with the text). Whenever she mentioned in the story something that was shown on one of her cards, she placed that card in front of her. Once she had used all her cards, her turn was finished and passed to the next storyteller, and so on. After all the players had finished their stories, the game entered the last phase where they voted for their favourite story. Players voted by giving their winning tile to the player who, in their opinion, told the best story.

The presentation of a game appears to be particularly important to motivate players (Lieberoth, 2014) so game components should look and feel professionally produced. Game components and rules were designed drawing on other storytelling games such as *Once upon a time* and *Tell-a-tale*. As for any game, I provided rules (Brandt, 2006) but left degrees of freedom (Baldissin et al., 2013, p. 85), for example over which cards to use and which stories to tell.

Figure 9: Cards used or not used during the game sessions. Which cards were fought over and which ones were part of a story that won

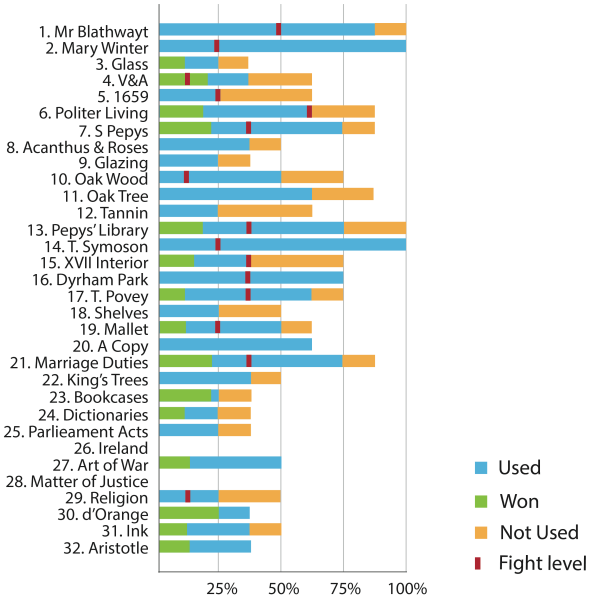


Table 6: Number, Title, Colour and Text for each game card

N	Title	Colour	Text
1	William Blathwayt	Red	(1649 – 1717) He was Secretary of War to William III from 1683 to 1704. His salary was considerable and supplemented by 'fees' for services such as helping expediting business with London
2	Mary Wynter	Red	(1650-1691) Heiress of the Dyrham estate. She married Blathwayt in 1686 when she was 36-year-old. She died 5 years after
3	Glass Presses	Red	During the 1710 inventory, the pair of bookcases were termed as "two Glass Presses"
4	Victoria and Albert Museum	Red	The Victoria&Albert Museum is the world's largest museum of decorative arts and design and was founded in London in 1852
5	1659	Red	The bookcase is one of a pair made for William Blathwayt in ca. 1695/1705, for the North end of Dyrham Manor, on the first floor
6	Politer Way of Living	Blue	Charles II's return to England encouraged a 'Politer Way of Living' with the collection and display of cultural artefacts, including books, and glazing
7	Samuel Pepys	Red	(1633 – 1703) He was Member of Parliament and Secretary of State to the Admiralty. He is most famous for the diary he kept for about a decade
8	Acanthus and Roses	Blue	Both upper and lower cornices are carved with acanthus foliage. The lower corner is also carved with petals and husks above a running pattern of roses
9	Glazing	Blue	The glazing not only protected but also gave greater value to the books. Glazing bars and doors followed the fashionable design of contemporary sash windows
10	Oak Wood	Blue	In the Middle Ages oak wood was used for interior paneling of prestigious buildings like the House of Commons in London
11	Oak Tree	Green	An oak is a tree or shrub of the beech family. It is native to the Northern Hemisphere, and extends to Americas, Asia, Europe, and North Africa
12	Tannin	Green	Oak wood is resistant to insect and fungal attack thanks to its tannin content. Tannin is a vegetable reddish acid, used to make ink and leather, it also gives an astrin- gent taste in wine
13	Pepys' Library	Red	Dyrham bookcases are similar to those designed in 1666 for Samuel Pepys. Pepys' book- cases were among first glazed cases and would have been much admired
14	Thomas Sympson	Red	A master joiner at the Dockyards under Pepys control. He constructed Pepys' library and may have designed Blathwayt ones
15	XVII Interior	Blue	The interiors of this period are remarkable for their richness, based on the forms and style of Ancient Rome. Acanthus leaves and cupids appeared everywhere
16	Dyrham Park	Red	Blathwayt was never ennobled, so when he inherited Dyrham in the 17th-century he built the Tutor mansion and the gar- den to express his status
17	Thomas Povey	Red	(1613/14-1705) He was Blathwayt's uncle and a merchant-politician. Because his friendship with Samuel Pepys, Blathwayt may have seen Pepys's library
18	Shelves	Blue	Each of the upper cupboard units contains three adjust- able shelves. The bottom section is wider and deeper to house folio volumes
19	Mallet	Red	The bookcase at Dyrham is a copy made by Malletts of Bath in 1927. Mallett is one of the oldest antique dealers in the world and was founded in 1865 by John Mallet
20	"A copy ..."	Red	The original bookcase was sold to the Victoria & Albert Museum. According to notes, in 1967 there were "2 bookcases at Dyrham", one being "a copy..."
21	Marriage Duties	Orange	A collection of rates and duties about marriages, births and burials, bachelors and widowers. By Gregory King (1648- 1712) an English genealogist, engraver and statistician
22	King's Trees	Orange	A discourse about the propagation of forest-trees in the king's dominions by John Evelyn (1620-1706), who was an English writer, gardener and diarist
23	Bookcases	Red	Shelving for book storage in houses was at the Restoration still very unusual and therefore much admired. Domestic collections were more often kept in chests or boxes
24	Dictionaries	Orange	A collection of universal dictionaries of arts and sciences, as well as language and historic dictionaries, by French and English Authors
25	Parliament Acts	Orange	Several volumes including collections of Parliament sessions and acts, ranging from 1688 to 1738
26	Ireland	Orange	A collection of statutes in use in the Kingdom of Ireland
27	Art of War	Orange	A treatise of the art of war written by Roger Boyle, 1st Earl of Orrery (1621-1679), a writer, soldier and politician
28	A Matter of Justice	Orange	Discussions upon justice statutes, parliament and ecclesiastic jurisdiction. Authors: barrister Michael Dalton, politician Sir Atkyns, and the Archbishop of Canterbury Sancroft
29	Religion	Orange	Sermons, New and Old Testament are discussed and ex- plained by religious commentators such as Samuel Otes, Anthony Farindon, John Trapp, and John Richardson
30	Prince d'Orange	Orange	History and live of Frederic Henry de Nassau Prince d'Orange. Written by Isaak Commelin (1598 - 1676) a Dutch historian
31	Ink	Orange	Manuscript about the composition of Ink, probably from early eighteenth century
32	Aristotle's physics	Orange	Old manuscript containing a corpus of Aristotele's physics. Written by Franciscus Vicomercatus (1474 - 1598), an Italian philosopher and physic

4.3.2 Players and trials

Before playing the game with visitors at Dyrham Park, I ran a pilot followed by a series of game sessions at the University of Bath. The purpose of these trials was to improve the game design and experience and to test the data collection process.

I tested the first prototype of *Tell-A-Dyrham-Tale* with four experienced game players, adults aged 24 to 35 years old, 2 male and 2 female. They were recruited from the members of local board game clubs. The players were asked to comment and provide feedback during the game and were interviewed after the game. In particular, they were asked whether the gameplay was clear and fun, and to suggest improvements.

This pilot was useful in improving the game design. For example, initially I auctioned the cards one after another, but players mainly bought the first cards offered and had no money left for the rest. Participants complained that they did not know which cards to expect. So I amended the game: cards were sold one by one but were all briefly described at the beginning of the auction. Thus, the players had an initial overview of the complete set. The first design also included a central board with a picture of the bookcase. Players were supposed to tell the story around this board. In this way, I intended to ensure that the story would focus on the bookcase. However, the experienced players found the use of the board limiting since the cards already conveyed information based around the bookcase. During the pilot, I also found that the game was giving too many game coins to each player to buy cards, so the amount of coins was reduced to make the game more challenging.

After the pilot, I ran four game session trials at the university with adults aged 24 to 35 years old. Players were recruited from students and staff of the university via posters and email. The game play did not change again as a result of these trials, however, they were a very useful exercise before running sessions with the public at Dyrham Park. I was present during all the sessions, playing as Game Master. Thus, at the end of these games, I more experienced and confident, for example in the presentation of the cards during the auction phase.

Finally, I ran four game sessions in the field at Dyrham Park with families and adults visiting the property. Thus, I ran Tell-A-Dyrham-Tale with 8 groups of players: 2 groups with 2 participants, 5 groups with 4 participants, and 1 group with 5 participants. In total, 29 people played Tell-A-Dyrham-Tale, 14 of which played at Dyrham Park. Of the 14 visitors who played TADT at Dyrham Park, 8 were children.

For the game session trials, I used a meeting space at the university, while at Dyrham Park I used William Blathwayt's old study. In both cases the game experience was facilitated by creating an informal and pleasant environment. For example, the meeting space at the university had sofas and low tables, a setting similar to a living room, while the room at Dyrham Park had comfortable chairs, a large round table and a fireplace. Tea and cookies were offered to the players during each session.

Table 7: Data from TADT was collected through photos and audio-recordings

	Photos	***Audio Recording***
During the game	Photos of the tabletop: game cards played and in which order; game cards not played; winning tiles received.	Audio recording of the full game session including the stories told
After the game	Photos of the emoji cards selected	Audio recording of the feedback

4.3.3 Methodology

The pilot study and the 4 trail sessions were used to improve the game experience and the data collection. These 5 sessions were documented through photos, direct observation, and audio-recording. The outcomes of these sessions were used to improve the game experience and data collection during the 4 sessions at Dyrham Park.

I was present at every session as a game master, so taking notes during the trial sessions resulted unpractical. Therefore, at Dyrham Park each game session was documented exclusively using photos and audio-recordings. After each game session, participants were also asked to briefly discuss their personal experiences with the game. These short interviews were also audio-recorded.

As with 1001DT (Section 3.2.1), TADT was also based on design methods including directed storytelling where prompts are used to collect stories and ideas from participants (Evenson, 2006). In particular, picture cards are often used as stimulus to facilitate storytelling and are particularly effective with couples and families.

Photos were taken to document which cards each player bought during the game and which ones were played (Figure 9 and 10). Photos were taken at the end of the session in order to not disrupt the game experience. I were particularly interested in which cards, and therefore which information, visitors considered valuable for telling a good story. Participants were free to use either the back or the front of the cards, so I could investigate whether participants preferred to use images or text to tell their stories.

I was also interested in what kinds of stories participants would tell. Hence, each game session was **audio recorded** to document players' stories, and comments during the game. While participants were informed that they were being audio-recorded, the recording device was not clearly visible so that would not influence nor disrupt the players. Moreover, while I provided a set of rules players had to follow (see Appendix B), players were still free to tell any kind of story so long as they used the cards as elements of the plot. In this way, I gave a degree of freedom to the players and I could gathering data about what kinds of stories they found more engaging.

Figure 10: Game sessions. Pictures taken of the tabletop with cards played during the game sessions. The photo on the left is from one of the trial sessions and shows four row of cards: the first player bought but did not use 3 cards to tell a story, then the other three players did not use 5 cards each. The other photo on the right is from Dyrham Park and shows which cards a player used, in the order they were used, and how many winning tiles his/her story received. In this case the player played 5 cards to tell a story and got 2 winning tiles.

4.3.4 Data Analysis

A document was created to report which card was bought, whether the card was used to tell a story and if that story won or not. I also recorded which side of the card was used (i.e. text or image). Thus, I run a frequency analysis to see how many times a card was bought but not used, how many times it was instead bought and used, and how many of these times the cards was used to tell a winning story.

The audio recordings of the full game session were transcribed into a Word Document (see Appendix D). Then, I carried out content analysis to identify recurring topics. Finally, I mapped the stories to specific narrative genres (see Table 9). For each genre I determined main features that could be linked for affinity to the stories told by players of the game. In order to identify these features and map the stories (see Table 8), I draw from a variety of sources: Frye's (1957) categorizations of the main narrative genres; the list of literary genres from the California Department of Education[17] ; and Saricks' (2009) book "*The Readers' Advisory Guide"*.

With her book, Saricks wish to facilitate librarians' work and promote the understanding of genre fiction. Saricks (2009) points out that she is not trying to classify genres because not every book fits in a specific genre and not all readers perceive books in the same way. Moreover, each genre can overlap, alternate, or combine. For example, we can have a tragic-comedy or romantic comedy. For ease of analysis, I did not use combination of genres. For example, I would not have classified a story as tragic-comedy but as both tragedy and comedy (Table 9). Like Saricks, I am not attempting to provide an objective classification system. However, I am suggesting a list of specific features for each genre (e.g. characters and plot) to facilitate the analysis of stories told during TADT.

Table 8: List of narrative genres with genre specific features (i.e. characters, mood/tone and plot)

[17] *https://www.cde.ca.gov/ci/cr/rl/litrlgenres.asp*

Category	Characters	Mood/Tone	Plot
Fantasy	Strange or other worldly characters. Clear distinction between good and bad	Generally optimistic, range from dark to humorous	Fiction inviting suspension of reality. Usually good vs evil: the heroes battle and conquer evil forces
Romance	Couples. Strong and dangerous men; strong, beautiful and bright women	Evocative, emotional	A love story. Character separated from each other or need to rescue, often because of a misunderstanding. Satisfactory resolution and happy ending
Horror	Haunted individual, sinister creatures and monsters	Dark, spooky and nightmare-like	Fiction in which events evoke a feeling of dread and fear in both the characters and the reader. Endings are usually unresolved
Tragedy	Variety of characters	Dark and gritty	There is a significant problem and an attempt to discover the truth and restore justice. Resolution at the end
Crime/Mystery	Variety of characters	Variations. From dark and gritty to light and witty	An investigation. Find clues and solve a crime, usually a murder
Adventure	Hero/s: a likable character with ingenuity and skills	Dark, moody, menacing, and sometimes with humor	Series of dangerous episodes to overcome in order to accomplish an important mission
Historical	Historical characters	Serious, either dark or light	Non-fictional story set in historical setting
Historical fiction	Real or fictional characters. Characters fit the historical period	From rollicking to somber, serious. Either dark or light, even humorous	Fictional story with accurate historical setting. Focus on a particular historical event or follow the life of a character
Comedy	Variety of characters	Light	Minor problem, often a mistake or false identity. Happy ending
Satire	Variety of characters	Light and comic	Episodic and opportunistic, involves elements of other genres. Usually about humanity and society
Science fiction	Variety of characters to highlight issues and set the atmosphere. E.g. aliens and otherworldly creatures	Variety. From dark to comic. Tone often use to disorient readers	Speculative fiction often set in the future. Story based on impact of actual, imagined, or potential science, usually set in the future or on other planets.
Thriller	Hero and antiheroes, usually a professional of some sort (e.g. spy, doctor, lawyer)	Dark with gritty details	Action story to tell the dangers of a particular profession. Often a political focus and conspiracies. Protagonists threatened by frightening perils

4.3.5 Findings

In this section I use the data collected through TADT to gain insights into visitors' interests (4.3.4.1) and perception of specific genre of narratives (4.3.4.2).

Which bits of narrative are more appealing to visitors?

I analyzed how often cards were bought and used, which cards were used in winning stories, and which cards were contested for during the auction phase (Figure 9). In general, players were particularly interested in the origins of the bookcase: why and how it was made. The game sessions also highlighted a strong interest in the women who lived in Dyrham Park.

Four cards were bought in every game (Figure 9): William Blathwayt (card number #1); Blathwayt's wife Mary Wynter (#2); Samuel Pepys' library (#13); and Thomas Sympson (#14), the craftsman who created Pepys' library and probably Blathwayt's (see Table 6). Other cards were bought in 7 of the 8 game sessions: Samuel Pepys (#7), Oak Tree (#11), Politer Way of Living (#6), and a book about Marriage Duties (#21). Politer Way of Living (#6) was also contested in 6 of 8 games, while Blathwayt (#1) was contested 4 of the 8 times it was bought in the auction. Blathwayt (#1), Wynter (#2), Sympson (#14) and Oak Tree (#11) were never used in winning stories. In contrast, Marriage Duties (#21), Politer Way of Living (#6), Samuel Pepys (#7) and his Library (#13) each won 40% of the times they were used to tell a story.

The cards representing Samuel Pepys (#7) and his library (#13) were particularly popular, together with Marriage Duties (#21), Blathwayt (#1), Wynter (#2), and Sympson (#14). The card with Lady Wynter was the only one of a female character, which players complained about. It is probably the reason why her card was always selected, especially if they wanted to tell a traditional love story. As best we can establish the historical facts, the Dyrham bookcase was directly inspired by Pepys' library, which is why the card set included information related to Pepys and his library. Sympson was the craftsman who built Pepys's library and probably designed Blathwayt's.

The popularity of these cards suggests that players were particularly interested in the origins of the bookcase. In contrast, players showed little interest in the books displayed on the bookcase, with the exception of the manuscript listing duties relating to marriages and births (#21). These findings provide suggestions of what content might be prioritized in the design of museum narratives based around the bookcase. Moreover, the back of the cards (i.e. textual information) was used just 3 times, while the side with images was preferred for all the other times the cards were used to tell a story. This too may inform visitor experience design, suggesting, for example, that the narrative should be strongly visual.

Table 9: Genre specific features mapped to each story: ID of the story (e.g. first story told = 1); characters and setting for each story; Plot and relative quote from the storyteller

ID	Genre	Characters/Setting	Plot	Quote
1	Historical fiction	Historical characters with a fictional story	Mallet used the trees at Dyrham Park were used to build bookcases	"Inside Dyrham Park there were millions and millions of oak trees (…) Mallet used to cut down these trees and build bookcases"
2	Horror	Historical characters (Pepys), haunted individual (i.e. William) and spooky setting	Pepys owned magic bookcase that trapped spirits. Unresolved ending	"William was trapped there"
3	Historical	Historical character and non-fictional story	Blathwayt owned a bookcase which was very well decorated	"Once there was a man called William Blathwayt (…) who had a library that was (…)well decorated"
4	Horror	Sinister creatures	Mary Winter discovers there are zombies hidden in the attic of the property and fight them. Unresolved ending	" (Mary) did not knew there were zombies hidden in the attic"
5	Crime	A thief	There is a crime: Povey stoles the bookcases. Resolution: the bookcases were sold and are found in the museum	"Povey stole one of the bookcases"
6	Historical fiction	Historical characters and fictional but historically plausible facts	Charles II promoted the use of bookcases, which is way his museum was filled with bookcases finely decorated with acanthus and roses	"Lots of bookcases in that museum that were from Dyrham Park (…) designed with lots of acanthus and roses"
7	Historical fiction and fantasy	Historical characters, fictional facts some suspension from reality	Povey liked Pepys' library and commissioned Simpson to build bookshelves for him as well. He hided clues about a treasure in the bookcases. If you search today, you might still find them	"(Povey) commission (Simpson) to make bookshelves with lots of secret clues about treasures"
8	Historical fiction	Historical characters and fictional but plausible facts	King Charles II was living in Dyrham Park and supported a politer way of living by banning books about was and commissioning beautifully decorated bookcases	"King Charles II (…) supported his campaign the polite way of living when he was living in Dyrham Park"
9	Fantasy	Suspension form reality and other worldly objects	The Prince d'Orange buys a new bookcase with a glass glazing. When the prince opens the bookcase for the first time, he finds a magic book that starts glowing and shaking once opened	"(the Prince) opened (the book) up and turned out it was written with magic ink"
10	Horror	Sinister creatures	Mallet was haunting Dyrham Park because he died in the house. One day Thomas Povey was in the house, focused on reading a book, when the phantom captured him. Unresolved ending	"Thomas was reading the dictionary and did not notice that Mallet was behind him (…) and then he got captured"
11	Romance and horror	Historical characters, a fictional love story, a phantom haunting the house	Pepys was the once who married Lady Winter, but she was in love with someone else. Her lover tried to kill Pepys but killed her by mistake. She is now haunting the house.	"He put lot of tanning in his tea. But what he did not realize is that Mary drunk the tea instead (…) so she felt asleep in her priceless interior (…) and she can be still found sleeping there today"
12	Historical fiction and romance	Historical characters, fictional but plausible love story	Mary Winter's beloved oak tree is stroked by lightening. Her husband hires a joiner to build something beautiful with the oak wood as a gift for her.	"Blathwayt went up the hill where the oak tree stood. Up there, there was the most amazing chair that was carved like a throne. (…) Mary could sit on it under the shades"
13	Fantasy	Mix of historical and other worldly characters	Pepys loved stories and kept a diary. He owned a bookcase. After he dies, the V&A bought the bookcase and discovered a hidden back with Pepys' secret diaries where he described his friendship with Spiderman	"He moved away this piece of wood and behind this piece of wood there was a whole other shelf and these shelves were filled with stories about Spiderman"
14	Historical fiction	Historical characters, fictional but plausible story	Blathwayt loved books so much he enforced an act of parliament saying that everybody should own books	"We should pass an act of parliament to be sure that everybody has have to have books. So that how it happens that from that day onwards, everybody had a bookcase"

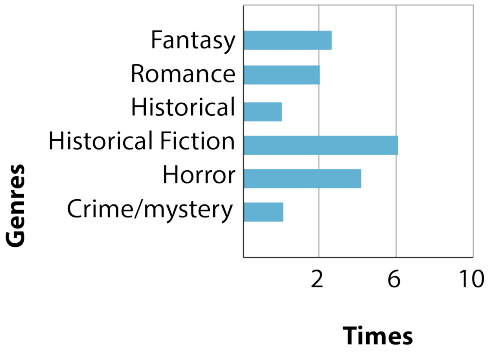
How do visitors perceive different narrative genres?

I examined which story genres were preferred by players (Figure 11). I identified six genres that were used: (1) Crime or mystery, in which a crime is committed; (2) Fantasy, about magic or supernatural forces; (3) Historical, about real people and events; (4) Historical fiction, which includes fictional details and characters that fit into an historical context. I considered a story to be historical fiction characters were real and the story was fictional but historically plausible; (5) Horror, that aims to scare, including for example stories of ghosts and monsters; (6) Romance, which focused on amorous relationships.

A story may belong to more than one genre if it includes elements from different genres. For example, a story could include elements of both romance and mystery. Most (6 out of 14) of the stories were historical fiction. One of these historical fiction stories included elements of romance and another one elements of fantasy. For example, they told the story of the marriage between Blathwayt and Lady Wynter, and they tell that Pepys was also in love with Lady Wynter. In another example, they imagined that there could be a secret letter hidden between the books. One player told a historically plausible story of the bookcase but at the end introduced a secret compartment hiding clues to find a treasure.

Only one participant told a story based exclusively on historical facts: a child who told how the bookcase was made. Other children usually preferred to tell horror stories. Horror stories were told in total 4 out of 14 times, which means 4 out of 8 children added spooky details and haunting creatures to their stories.

Figure 11: Story genres. Times each genres of story was told through TADT



Notes on historical authenticity and entertainment

Players apparently considered historical information not sufficiently engaging to win the game. Tellers often added a few fictional details to make the story more engaging and attract more votes. Indeed, just one historically accurate story was told and won: a story narrating the origin of the bookcase design. The other winning stories were either fiction or historical fiction. Thus, the game provided us with

insights regarding which kinds of information players were most interested in, and in which form (pictorial or textual) they preferred the information.

On one hand, historical accuracy is important for cultural heritage institutions that need to maintain their authority in order to maintain their status (Murphy, 2007) and must concern themselves with authenticity. On the other hand, the mere listing or display of historical facts and artefacts does not always appeal to the public (Hargrove, 2003; Sanders et al., 2010), where instead powerful narratives can reach, engage and entertain people more effectively (Chamberlain, 2011). It is a delicate balance to achieve for institutions that have a long established mission to protect and to share authentic objects and information (Murphy, 2007), and an emerging imperative to entertain and engage in the face of new, often technology-driven, competitors for visitors and for the funding that often follows them.

4.4 Making Games as a Research Method

In the previous chapter I described *playing* Tell-A-Dyrham-Tale, a storytelling game, as a method to collect data from players to inform new narratives. However, playing a game is only one side of the coin. Researchers such as (Chatham et al., 2013; Deen et al., 2014; Preston et al., 2012) have suggested that game jams – so the making of games during a very short period of time - could be a valuable research method in disciplines including HCI. According to Deen et al. (2014), both the design process and artefacts can be used as a case study to explore specific research questions, particularly with younger people. Deen et al. (2014) also introduce the idea of using game jam as a research through design method, particularly with exertion games.

While the making of games through game jams has been used as a design method (Kultima, 2015a) and as a method to explore specific research questions (Deen et al., 2014), much is still unknown about how game jams can be used as a research method, either on their own or as part of a broader research methodology (Goddard et al., 2014). The idea of game jam as a research method is still at an exploratory stage and the published literature consists mainly of short papers such as (Deen et al., 2014) and (Chatham et al., 2013). The little research that has been done in the field is mostly to evaluate a game jam as an event *per se* (Fowler et al., 2013; Locke et al., 2015). Moreover, game jams are typically not recorded or documented in a way that enables to evaluate game jams as a potential addition to their methodological toolkit (Locke et al., 2015).

In this chapter I report the second example of RtG where I collected data as users *make* games. This was achieved by organizing *GameTale*, a game jam during which participants developed games based on digital artefacts. I designed GameTale as an RtG activity to research how people perceived and interpreted digital artefacts in museums. In particular, through RtG I collected data to answer two main questions: (1) How do participants perceive and interpret digital artefacts? (2) How do participants perceive digital artefacts within games?

4.4.1 GameTale

GameTale was a game jam hosted over 2 days at the University of Bath, followed on the third day by a showcase of the games presented to the public in the exhibition space at Bath Royal Literary and Scientific Institution (BRLSI). During the two-day game jam, participants had access to the 3D reproductions of 5 digitized cultural heritage artefacts[18].

The first artefact was a Delft ceramic urn made in 1690 (Figure 12). One face depicts four horses and riders in classical military dress, supported by a foot soldier. The other depicts a seated queen wearing a crown and holding a sceptre. The second artefact was a 19th century sculpture comprising a leopard and a drum (Figure 13). It is likely that the artefact was connected to ceremonies of a leader of the Fante, a community living in Coastal Ghana. The third artefact was a Romano-British bronze brooch made during the 1st or 2nd century CE (Figure 14). It has 6 circular sockets that probably held gems or enamel inlay. The fourth artefact was the tooth of an ichthyosaur, *Temnodontosaurus eurycephalus,* about 190 million years old (Figure 15). The ichthyosaur is an extinct marine reptile that resembled a dolphin and grew to approximately 9 meters. The fifth artefact was the complete skull of *Pelagosaurus typus*, a group of marine crocodylomorphs from the Early Jurassic to the Early Cretaceous (Figure 16). *Pelagosaurus* measured up to 3 meters in length and resembled modern crocodiles.

Figure 12: Delft Ceramic Urn from the National Trust collection. The 3D model of this artefact can be visited at https://sketchfab.com/models/df0fac82c68d4585b3cbc17d58deda4c

[18] *https://gametale.org/2016/05/14/discover-the-objects-for-gt-2016/*

Figure 13: Leopard with a Drum from BRLSI

Figure 14: Romano Brooch from BRLSI collection. The 3D model of the brooch can be seen at https://sketchfab.com/models/f1ed85f2c19145139502b16d3303b1d2

Figure 15: Tooth of an ichthyosaur from BRLSI collection. The 3D model of the brooch can be seen at https://sketchfab.com/models/76db7da26d7b4faf9b8375ad5da460ba

Figure 16: Pelagosaurus Skull from BRLSI collection. The 3D model of the brooch can be seen at https://sketchfab.com/models/2b6aef665df8447884eb492f1db14eb7

The original artefacts came from the collections of the National Trust (the UK's largest network of accredited museums) and the Bath Royal Literary and Scientific Institution (BRLSI; one of the UK's oldest museums). The reproductions included virtual 3D models, digital photos and 3D-printed replicas, created from the digitization of the original artefacts. The use of digitized artefacts reflects museums' growing collections of these digital assets which are increasingly central to their aspirations to create both entertaining and educational user experiences (Langer et al., 2014b; Wachowiak and Karas, 2009). Museums have begun digitizing their collections mainly for conservation purposes so their digital assets are often archived and not shared with the public (Wachowiak and Karas, 2009). However, museums' mission is not just to conserve knowledge but also to share it (Murphy, 2007). Museums increasingly feel pressure to offer more interactive and entertaining experiences in order to drive visits and support their goals of education and conservation (Simon, 2010). GameTale offered us the opportunity to better understand how these expanding collections of digitized assets can be used to support this goal.

Each team of participants was asked to develop a video or board game that included at least 1 of the artefacts. Two weeks before the event, each artefact was published on the event website (https://gametale.org/), including pictures and a short description. More information was sent by email one week before the event and the artefacts were also presented on the first day, during the opening of Game Tale. During the event, we encouraged participants to use the Internet to find additional information about the artefacts, their history and context, as well as to ask us questions.

4.4.2 Participants

The game jam participants were recruited through a range of channels including posters and digital displays around the University of Bath and via newsletters managed by a local Innovation Centre, another university, the Centre for Digital Entertainment, and in games and museum conferences (e.g. DIGRA and ECSITE). It was also advertised on Facebook, and through games clubs. The publicity explained briefly what GameTale was, that it was free to attend and included a link to the event website which provided additional information and online registration.

26 people, 9 female and 17 male, aged between 19 and 49, registered as participants. They could register either as individuals or as part of a team. The majority of the participants already had a team. Just four participants registered as individuals and they created a team together at the beginning of the game jam (team 1).

The day after GameTale, the games were exhibited to the public. Although 9 teams attended the event, three games were not ready to be played. Therefore, 6 out of 9 games were exhibited during the showcase (game 1, 2, 3, 4, 7 and 9). During the public showcase, 9 visitors who had played at least 1 game were randomly selected for interview: 4 children (aged 5 to 12 years) and 5 adults. Of these, 1 adult and 1 child were part of the same family (mother and son) and were both interviewed. The parents of the other children did not agree to be interviewed. The other 4 adults were 2 younger women and 2 older women visiting the exhibition as 2 pairs of friends.

4.4.3 Data Collection

Although game jams have not been widely applied as a research method, they have been used as a tool to analyse game design and participants' motivation. Thus, we followed a similar methodology to previous studies (Locke et al., 2015; Musil et al., 2010; Reng et al., 2013; Zook and Riedl, 2013): questionnaires before the event, interviews and direct observations during and after the event, adapted to research questions around the design process and the perception and interpretation of digitized artefacts. In particular, we investigated the game designers' awareness of the historical/scientific value and context of the digitized artefacts. We also investigated how the game designers interpreted the artefacts in their game designs. For example, if they used historical/scientific information within their game or just used the artefact as a game object. Finally, we investigated how players perceived the artefacts through playing the games. For example, did players recognize the artefact and learn anything of its historical/scientific value? This end-to-end analysis promoted a better understanding of how designers understood and used the digitized artefacts at the heart of interactive visitor experiences and to what extent visitors then enjoyed the designed experience and gained some learning or appreciation of the artefacts.

Day 1 began with introducing the event schedule and the artefacts. After breakfast, each group started thinking about their games. On both days there was a break for lunch at 12:00, drinks and snacks at 15:00 and dinner at 19:30. After dinner, each team presented their game concept. The game jam closed at 21:00 on the second day, after the final presentation. On the third day, the games were set up as a visitor experience at the BRLSI and were exhibited to the public from 14:00 to 17:00. During this showcase exhibition, visitors could play the games and talk with the designers.

Table 10: Questions included in the online survey

Basic Information
Name, Job, Age. Email
Background Information
How often do you play videogames?
How often do you play boardgames/cardgames?
How often do you visit museums?
Information related to GameTale
How did you find out about GameTale?
Are you already part of a team? (if yes, indicate emails of other members)
Consent Form (Consent for taking pictures and videos of the event)
License Agreement (Information related to copyright)
Age Restriction (Confirmation participant is at least 18 years old)

Pre-Questionnaire

We included a survey with the online registration. We asked for basic information such as age and job title and specific information such as how often they visit museums. We asked how often they play video or board games and which they preferred. Finally, a consent form asked each participant's permission to take pictures and videos during the event and to share them.

Table 11: Guidelines for the semi-structured interviews carried out during the two days of GameTale. The Basic questions never changed, while questions related to the artefacts/ Objects and the Game evolved three times during the event.

	Version 1	**Version 2**	**Version 3**
BASIC	Name team Name game Team members	Name team Name game Team members	Name team Name game Team members
OBJECT	Which object/s How many objects used? How intend to used the object/s in the game What team knew about the object?	Which object/s Why those objects were chosen? How objects were used in the game Did you search any information?	Did they change the objects used? Why? Is the historical background of the object used anywhere in the game?
GAME	Why are you making a game? Which tool/s are used to develop the game Which type of game? Any inspiration for the game?	Which type of game? What is the story/purpose/ theme of the game?	Was the game changed somehow? Why? What are the game rules? What is the goal of the game? What is the expected players' experience?

Days 1 and 2: GameTale

In order not to disrupt participants, over the two days each team was interviewed during coffee breaks and lunches. Thus, each team was interviews 5 times in total during GT. Since I was working over breaks, the interviews had to be carried out in a short time. Therefore, the interviews were carried out by 3 interviewers simultaneously. In order to guarantee continuity, the interviews were semi-structured. Before GameTale, 3 research assistants were trained to observe

and interact with the participants and collect data. They were instructed about which information to prioritize and record using a checklist to guide their interviews. Before each break, the researchers were briefed again and were given a checklist of questions.

Each checklist included an area on top where to add basic information such as team number and names of members. There were also checkboxes to indicate which artefact/s the team was using and whether they changed objects. Then, the checklist included a set of questions with a space below each question where to add notes. The questions in the checklists changed during the 2 days, focusing at first on selected artefacts and tools, and participants' personal interests. For example, we asked which artefacts were selected and why, and what role those artefacts had within the game. We also asked whether the team had read the information related to the artefacts on the GameTale website, if they did additional research and what were their motivations for participating. We also investigated if the game had a narrative and if that was related to the artefacts. While during the first day participants focused on game concept and narrative, on the second day they worked mostly on developing the game, so we asked more questions related to the game play, including rules and goals.

The interviewers' notes recorded in the checklists were then transcribed and labelled with the day and time the data were recorded. The close of day presentations were video-recorded and transcribed to provide us with additional data regarding the games and how they evolved. On the first evening, the teams presented their game concept. On the second evening, they presented their final game.

Table 12: Questions asked during the showcase. I also observed for how long someone played a game and how someone played a game, e.g. facial expressions, and if players had any comments

Basic	Age range
Object	Is the game inspired to something/remind of something? What is the main object of the game (Prompt: do they recognize the artefact?)
Game	Is the game fun to play? What they remember of the game (after playing) Did they ask any questions?

Day 3: Game Showcase

On the third day, the games were exhibited to the public at BRLSI. Again, the interviewers were trained and given a checklist of questions to guide semi-structured interviews with randomly selected players. During the showcase, 2 interviewers observed visitors as they played the games, taking notes about visitors' behaviour while playing the game. After the game, the interviewers conducted interviews designed to give us insights into how visitors perceived both the games and the digitized artefacts. We asked what they played and if they enjoyed the game, whether they remembered any specific information about the game artefacts, and if they thought the game was inspired by a specific topic or artefact. The final

questions focused on general game and play experience. We also noted if the player was an adult or a child, recording the age of children.

4.4.4 *The Games Developed*

In total, 9 games were designed (Table 13): 7 computer games, 1 board game (game 2) and 1 mixed reality game (5), i.e. a board game supported by an Augmented Reality (AR) application. When we asked participants to tell us why they joined GameTale, members of the same team had the same motivation, including team 1. While two teams (6 and 8) did not record a specific reason for registering for GameTale, the others offered the following reasons:

- To learn something new (teams 1 and 3)
- To develop a fun game (teams 2 and 9)
- To feel a sense of achievement (team 4)
- To compete against other teams (team 5)
- To practise previously acquired skills (team 7)

Table 13: List of games developed during GamteTale. The table indicates the type of game developed, the artefact/s included in each game, and the general purpose of each game

1	Text-based web game	All 5 artefacts	Players need to solve a set of quests per each artefact to complete the game
2	Board game	All 5 artefacts	Players need either to steal or defend artefact in the house of a private collectors
3	3D Videogame	Brooch	Players need to collect brooches jumping between platforms
4	3D Videogame	Brooch	Players need to rotate the brooch in order to recover its lost gems
5	Mixed Reality Game	All 5 artefacts	Players are either smuggler or archaeologists who need to find the artefacts
6	3D Videogame	Leopard with drum	A strategy game where players are African tribes trying to collect land
7	2D Videogame	All 5 artefacts	Players explore a set of rooms to find artefacts while avoiding monsters
8	2D Videogame	Pelagosaurus skull	Players are a Pelagosaurus trying to collect food while avoiding obstacles
9	3D Videogame	Brooch	Players need to jump up a long flight of stairs without fall in order to collect the brooch

The *first* team had 4 members and developed a web-based game. They used all five artefacts. Each artefact was located in a virtual room, within a virtual museum. Each room included a quest that players had to solve by reading a series of information about one of the artefacts. The goal was to solve all 5 quests in order to be able to tour and exit the museum. The game was developed initially with Inform7 [19], a programming language and design system for interactive fiction. However, this software could not include images. Therefore, the team migrated to

[19] *http://inform7.com/*

using Squiffy[20], another tool for creating interactive fiction that allowed adding images to their interactive story.

The *second* team had 5 members and developed a board game. They used all the artefacts. The artefacts were located in specific locations within the house of a private collector. The house represented the central board of the game. Players split in two competing teams: thieves and guards. The guards worked for the collector and had to defend the artefacts by finding all the thieves in order to win. The thieves had to steal 3 artefacts in order to win. Two artefacts were randomly selected from a pile of cards and the thieves chose the third. While all the players knew where the artefacts and the guards were, the thieves' location was secret and they planned their moves in secret. Guards were openly looking for the thieves, whom they could see only when in line of sight.

The *third* team had just 1 member, who developed a computer game. Initially this team included two members, but the team split the first day and one of the players created a new team to develop his own game (i.e. team). The brooch was the only artefact used for this game. The purpose of the game was to reach the final platform, jumping from one platform to another, in order to get the brooch. The game was developed in Unity using C#. Players had to follow rules of physics in order to jump between different types of platforms and not fall down.

The *fourth* team had 3 members and developed a computer game. The brooch was the only artefact used for this game. Located within an abstract tunnel at the center of the screen, the brooch could be rotated using a Leap Motion sensor. Players rotated their hand over the sensor and by doing so rotated the brooch and collected gems of different colors located around the brooch. In order to win, players had to collect 1 gem of each color.

The *fifth* team had 3 members and developed a mixed reality game, a board game augmented with a tablet-based app. All the artefacts were used for this game. Artefacts were collected by two opposing teams, smugglers and archaeologists, by moving around a board. Moves were based on dice throwing. During each turn players picked up cards to gain specific abilities or encounter obstacles, e.g. go back spaces. The board game was augmented using a Google Tango tablet, which helped keep score and visualized 3D models of the artefacts to be found through the exploration.

The *sixth* team had 2 members and developed a computer game. The game was inspired by the leopard and drum artefact. This team did online research about African tribes, their history, names and totem animals. Hence, in the game there are at least 2 tribes, and the leopard is the totem animal of one of them. The tribes are free to move and contest for land. The mission of the game is to collect as much land as possible.

The *seventh* team had 2 members and developed a computer game using Java. They used all the artefacts for this game. In order to gain the artefacts, players

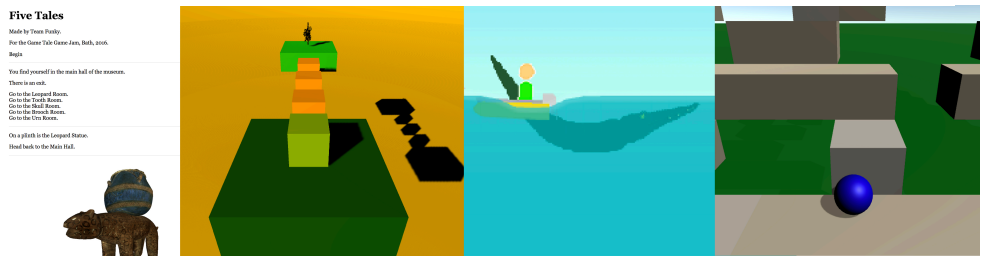
[20] *http://textadventures.co.uk/squiffy*

had to explore a 2D environment and successfully fight monsters. Initially, the virtual environment was just a grid. But the game design evolved through day 2 and by the end players moved around rooms with brick walls all around. A tiled floor created a grid. Players could move up and down, left and right, one tile at time.

The *eighth* team had 2 members and developed a 2D computer game inspired by the Pelagosaurus skull. However, they did not use the reproduction skull directly. Instead, they designed a 2D Pelagosaurus using Flash. Because the Pelagosaurus was a marine-adapted crocodile, the character was shaped like a crocodile continuously swimming in water. Players could control whether the Pelagosaurus was swimming straight, jumping or diving down. The goal of the game was to guide the Pelagosaurus to collect food and avoid obstacles.

The *ninth* team had just 1 member who was originally in the third team. Similarly to the third team, this team also developed an abstract computer game using the brooch as only artefact. The main character was a sphere that had to jump up a set of stairs. Players had to follow rules of physics to jump correctly and not fall. The goal was not simply to reach the brooch at the end but also to protect it from other players for 2 minutes, keeping the sphere going up the stairs.

Figure 17: Starting from the left, a screenshot of the game developed by team 1, 3, 8 and 9



Through analysing the games produced and their designers' comments, I identified 4 game goals that reflected to different degrees the museums' twin aims of entertainment and education:

- For teams 4, 6 and 8, the main goal of their game was to offer an entertaining experience. Those teams developed games where players collected either objects or land.
- For teams 2, 3, 5, 9, the main goal of their game was to offer a challenging and competitive experience. In the games, people should play to win.
- For team 7, the main goal was exploration, thus players' main purpose was to explore the game environment.
- For team 1, the main goal was to educate, so that players could learn more about a specific artefact.

Each game provided different degrees of freedom. Although freedom can

encompass "all of the game resources players can master" (Shi and Shih, 2015), when we consider *degrees of freedom* we focus on the ways in which players interact with the game. For example, in linear games players have to follow a fixed sequence of challenges so there is a limited freedom of choice, while in non-linear games players can choose among different paths (Rollings and Adams, 2006), such as in role-playing games (Oehlerking, 2015). However expansive or constrained, freedom is considered a core characteristic of games, especially educational games (Wilson et al., 2009), so players are usually allowed basic control over strategy (Baldissin et al., 2013). In 5 of the games developed during GT (1, 2, 5, 6, 7), players could decide a strategy and take different directions. For example, in both games 1 and 7 the players could decide which rooms to visit and each room would provide a different experience. The other games offered a more directed experience as players completed the same series of actions. For example, in game 3 the players had just one direction to follow, jumping over cubes to arrive to the top, while in game 4 players just rotated the brooch right or left to collect a tightly constrained number and type of gems.

4.5. Findings

In this section I used the data collected through GT to gain insights into how game developers perceive and interpret digital artefacts (4.5.1) and how players perceived digital artefacts within games (4.5.2).

How do participants perceive and interpret digital artefacts?

Each game was designed around one or more objects. The brooch was used the most, with 3 teams (3, 4, 9) using it as their only artefact. One team (8) selected the skull, 1 team (5) the urn, and 1 team (6) the drum with leopard. 3 teams used all five artefacts. 6 teams chose their artefact early on day 1 and stuck with it, while 3 teams (1, 4 and 5) finalized their choice on day 2. For example, on day 1 team 3 wanted to use two artefacts: the brooch and the urn. By day 2 they decided to use just the brooch. Team 5 wanted to use all the artefacts at first, but by day 2 had decided to use just the urn. The teams gave different reasons for their choices of artefact:

- Four teams (teams 3, 4, 5, 9) had an initial idea of the game they wanted to develop so selected the artefact that best fitted their idea.
- Team 6 was particularly interested in the historical background of the artefact.
- Team 8 simply liked the artefact, considering it "cool".
- Three teams (1, 2, 7) decided to use all the artefacts because it seemed like a challenging task. Team 1 in particular designed a task for each artefact.

Thus, with the exception of team 6, participants did not choose their artefact/s based on their history. However, 4 teams (1, 2, 5, 6) looked at the information provided on the event website. 2 of those 4 teams (1 and 5) asked questions of the interviewers in order to better understand some of the artefacts. Teams 1 and 6 looked for additional information beyond that; team 1 searched for accurate

information related to each artefact, while team 6 researched online African tribes and their customs to design a game around the leopard with drum.

Another two teams demonstrated partial interest in the historical and scientific background of the digital artefacts. Team 7 read the basic information sent by email to all participants but not the website. Team 8 did not look for additional information and initially did not read the information published on the website. However, they listened to the presentation of the artefacts on the first morning and later searched for information related to the Pelagosaurus skull. They learned enough to know that the Pelagosaurus was a marine-adapted crocodile, therefore they shaped their 2D Pelagosaurus like a crocodile.

Teams 3 and 9 (see Figure 18) did not demonstrate any particular interest in the historical or scientific context of their selected artefact. Both teams used the brooch simply as a jewel, a game collectible. In contrast, team 4 developed a game around the brooch but they acknowledged the intrinsic value of the brooch and its history. In particular, they were aware that the jewel had 6 circular sockets that probably initially held gems and they developed a game to collect gems in order to "restore what it might have looked like".

Figure 18: Participants of team 3 and 9 programming their games

Once the artefacts are chosen and included in a game, they might acquire a specific meaning for the designers. Although each team demonstrated a range of interest in the historical or scientific background of the artefacts, they all conferred on their artefacts importance within their games.

On day 1**,** just 4 teams (2, 4, 8, 9) explicitly acknowledged the historical or scientific value of their artefacts within their roles in the games. Team 9 considered the brooch as a valuable jewel to protect and designed the game so that players had to defend the brooch from other players. Team 4 located the brooch right at the center of their game and adjusted the game concept to accommodate the artefact's historical background. On day 1, team 2 regarded the 5 artefacts as valuable objects that should be shared with the world. While 4 teams (1, 3, 5, 7) were unsure about the intrinsic value and role of their artefacts, team 6 declared that the artefact was

not directly part of their game but just "inspired part of the game.

By day 2 all participants stated that their artefacts had an important role within their game. During the final presentation on Day 2, team 4 stated that their game allowed players to travel back in time to collect the lost gems of the brooch. Team 8 explained how players played "as a Jurassic crocodile inspired by the skull". When interviewed, they confirmed that they designed their character as a crocodile because their game was strongly influenced by the Pelagosaurus skull. Teams 1 and 5 were previously unsure which artefacts to include in their game and in what roles. By day 2, they had a much clearer idea of what they wanted to achieve. Team 1 explicitly presented the objects as museum artefacts, displayed in a virtual museum. A story based on their historical background was provided for each artefact. For this team the overall narrative was particularly important, so if the story of an artefact did not fit with the others, they would have removed that artefact from the game.

Then, team 5 decided to use just one artefact (i.e. the urn) instead of all five. The team explained that their artefact was valuable because of its age. Players were either archaeologists trying to uncover this valuable item or smugglers trying to steal it. Team 7 wanted to use all 5 artefacts but still did not know how. They had not finalized their game concept and the roles of the 5 artefacts. Finally, team 6 initially regarded their artefact as just vaguely inspiring the game. By day 2, however, they stated that their game narrative was directly based on the artefact's historical background. They used the leopard with drum. The leopard was a royal symbol of power for the Fante people and this game included African tribes contesting land. The tribes were based on additional research the team did starting from the origins of the drum in Africa. They even included the leopard in the game as the animal totem of one of the tribes.

How do participants perceive digital artefacts within games?

Through the public showcase I investigated players' experience with the games and how the digitized artefacts were perceived. 7 out of 9 games were displayed while 2 where not completed on time. I gained information regarding the 7 games showcased through interviews and direct observation. In total, 9 people were interviewed. The result of my direct observation was a set of notes on who played specific games and players' behaviour.

Some games were preferred by children (e.g. game 3), others were played mostly by adults (e.g. game 1), and others again engaged both adults and children (e.g. game 2). Some games stimulated social interaction (e.g. game 2 was usually played by 5 people together), while others were played individually. Game 4 was intended as single player game, however people tended to crowd around and observe. In general, visitors enjoyed their experience. Two parents asked us if they could find the games online so their children could play them at home. Many of the parents thanked us because their children had such a wonderful time and felt a sense of accomplishment. For example, a 12 year old boy commented: "I am not a gamer, I don't have an Xbox or anything, but I have made it to the last stage. I am good at

this".

However, not all games were played through to the end. For example, in both games 1 and 7, players had to explore rooms and solve challenges in order to obtain the 5 artefacts and win. In practice, players were not engaged enough to visit more than 1 or 2 rooms in each game. The only game that was always completed was the board game (game 2). Game 2 was also the most tested during GameTale, which means the developers could collect feedback and improve the game play. Other reasons for not completing the game was the difficulty of the game controls. For instance, players of game 4 were unfamiliar the Leap Motion sensor and so they focused much of their attention on learning how to control the game. With the exception of a child who learned immediately and played without problems, the other players spent their time trying to learn how to use the Leap motion rather than playing the game itself.

Another issue that could be related to playability is that 5 out of 9 players interviewed were unsure which artefacts were involved in the games. For example, game 3 involved jumping on cubes to collect the brooch at the end of each level. Two children who played game 3 thought the cubes themselves were the artefacts. Similarly, a child who played game 9 expressed surprise that there was an antique brooch somewhere in the game. Game 9 was a race up a staircase in order to find the brooch. The challenge was to jump without falling but the game controls were complicated to use, so not every player was able to complete the game. The child did not reach the top of the staircase so he did not see the artefact

In other cases, participants noticed the artefact but learned nothing about them. That is, they did not know what the objects were exactly, what their history was. For instance, a pair of friends played game 1 and then game 2. They remembered the artefacts from game 1 and recognized the same artefacts in game 2. Game 2 is a board game where players defend the five artefacts for a private collector or steal them. Most players recognized and remembered which artefacts they had to defend or steal in game 2 because each artefact had a token with a picture. Game 1 presented a story for each artefact, highlighting each artefact and providing related information. Although game 1 was very easy to use and informative, it was not engaging enough to be played to the end. Moreover, players tend to visit only a couple of room and to remember just the object itself, not the story related to it. While the boardgame (i.e. game 2) was very engaging and people always played to the end, but it did not present any information related to the artefacts. In both games people remembered just the artefacts but had not idea what they were, what their history was.

Notes on Authenticity and Entertainment

Most of the games developed during GameTale were engaging, but they did not appear to be particularly informative. While educative games were not always engaging. For example, the findings suggest that providing too much textual information can require too much effort and cause players to lose interest (e.g. game

1). Instead, game 4 was very entertaining and was able to deliver one clear concept visually, without text, but it was less informative and the game controls were complicate to use, a problem that could be overcome with additional testing and refinement of the game design.

Moreover, GT produced only 1 heritage-based game and 1 educative game trying to tell a story for each object. The other games either used the objects as museum artefacts but without an historical background (e.g. game 2) or as a mere game component (e.g. game 9). This was maybe due to the fact that developers were left with too much freedom: they could use any object as long as they include it in the game. While the event guidelines online and in the registration form specified participants had to tell a tale (hence GameTale) about the artefact/s, this fact was not highlighted during the event itself. Thus, in the next edition of GT I will further investigate whether less artefacts and a clearer constraint can increase the heritage content. GT will offer three artefacts and participants will be asked to develop a game around only 1 of the artefacts. Moreover, participants will be reminded during the event that they are supposed tell a story about the object through the game.

4.6 Discussion

Innovations in technologies and practices can test the limits of research methods, encouraging researchers to modify and adapt existing methods or even to develop new ones (Kaye, 2007; Ramey et al., 2007). I propose RtG as a method through which I can gain data about and from game players and game creators for research purposes. Zimmerman (2007) argued that the effectiveness of research through design methods should be assessed based on the novelty and relevance of their results. Similarly, the *results* of using RtG methods should be both novel and relevant, or meaningful, to their target community. I used RtG to collect data, produce knowledge, solve problems and inform the museum context.

Through **TADT** (Section 4.4) I gained knowledge to answer two main questions: (1) Which bits of narrative are more appealing to visitors? (2) How do visitors perceive different narrative genres? Visitors were interested in discovering the origin of museum objects and learning about people who lived in the historical property. In particular, players were curious about the women, what they did and how they lived. Moreover, players apparently considered historical information not sufficiently engaging and added fictional elements (e.g. mystery and fantasy) to make their stories more appealing.

Through **GT** (Section 4.5) I gained knowledge to answer two main questions: (1) How do participants perceive and interpret digital artefacts? (2) How do participants perceive digital artefacts within games? Participants demonstrated an increasing interest in the artefacts and their history while they were designing the games. At the end, 9 games were developed. However, only one game was strongly based on the historical background of the object while another was educative and tried to deliver information regarding the artefacts. The other games used the

artefacts mostly as a game component. As a result, visitors find the games generally engaging but did not perceived the objects in the games as artefacts.

Thus, RtG provides an understanding of players and their interests, thus defining the *content* of future experiences. The museum context is an excellent testbed for RtG as the design of exhibitions is increasingly required to combine education and authenticity with entertainment. While digitizing their collections and recognizing the need to engage with their visitors, museums are worried about how to share that digital content with their visitors. Values are changing and museums are struggling to adapt, conflicted between their need to conserve content in an authoritative way and engage their public through sharing it in an entertaining way. Museum objects should be interpreted in terms that are relevant to the public, stimulating a positive cognitive effect with minimal effort, for example by creating new connections with things we are already interested in, topics that are familiar and we care about (Simon, 2016). RtG help to us to tackle these controversial issues by engaging the public directly but playfully in revealing what they are interested in.

Narrative is a key element in engaging gameplay, and both the narratives intended by the creators of a game and the narratives created and experienced by the players can help us in using RtG to design better interactive experiences. Players or visitors may wish to know the story behind an artefact or event or character. For instance, they may want to know why and how and object was made, or why and how a specific event happened. Objects and people are connected through history, so visitors may also be curious about the people who used the objects, their personal stories and human experiences. If we just see a painting, a portrait of an historical character, we may not relate so much if we are not able to humanize the subject, to see her as a human being with a life and story. Objects are typically part of such a life. Knowing an object's history helps us to connect, to create meaning. Thus, stories should include people but not just the "main character". If we present just one character, we present just one perspective, which may be relevant to one visitor but not to others.

During TADT, participants asked for more information about people other than Mr. Blathwayt, such as Lady Wynter and Thomas Sympson. The history of Dyrham Park is strongly connected with the story of Blathwayt but players wanted to know more about other people related to the property, such as the craftsman who made the bookcase (i.e. Sympson) or the women who were involved in the story of Dyrham (e.g. Lady Wynter and her daughter). For example, what was their life like? Whom did they love?

Some players preferred simply to quote historical characters and facts, drawing on the cards in an unadorned manner. However, the majority of players became 'storytellers', with a tendency to spice up the historical stories with some touch of mystery, horror or love affairs. For example, throughout the stories the bookcase maintained its original purpose of book display but participants imagined letters and manuscripts hidden between books, and even an entire library concealed behind the bookcase itself. While the timber from which the bookcase was made became wood from a specific tree under which Lady Wynter used to sit. Mary

Wynter was no longer just Blathwayt's wife; she could have secretly loved Blathwayt's uncle, Thomas Povey; or maybe Sympson was secretly in love with her.

These examples are fiction or at least narrative elements for which there is not historical record. However, such stories can stimulate visitors' interest and their curiosity to know more. On one hand, historical accuracy is important for cultural heritage institutions that need to maintain their authority in order to maintain their status (Murphy, 2007) and must concern themselves with authenticity. On the other hand, the mere listing or display of historical facts and artefacts does not always appeal to the public (Hargrove, 2003; Sanders et al., 2010), where instead powerful narratives can reach, engage and entertain people more effectively (Chamberlain, 2011). It is a delicate balance to achieve for institutions that have a long established mission to protect and to share authentic objects and information (Murphy, 2007), and an emerging imperative to entertain and engage in the face of new, often technology-driven, competitors for visitors and for the funding that often follows them. In this context, it is even more important to understand and to decide not only what content should be presented to visitors but also how it should be presented.

Through the game I were able to successfully identify which characters and objects were particularly appealing for the players, such as Pepys and his library, and Lady Wynter. I also gained a better understanding of how this content can be delivered to the public through engaging narratives. For instance, I found that the presentation of historical information alone was not enough. To appeal to most visitors, the narrative needed to be more engaging, including elements of storytelling such as love and mystery.

Digital technologies are allowing museums to reach a wider audience. They are also providing additional (virtual) space where museums can share stories. However, there are many different technologies available to museums and many ways in which they can be used to share information. Museums often do not have the knowledge and resources to determine which technologies to use and how. Moreover, contemporary museums are often worried about focusing too much on entertaining, losing their perceived authority and becoming mere entertainment parks (Wolf et al., 2007). Through game creation and game play based, I also investigated *how* museum should share their content. For example, children enjoyed challenging games with no explicit concern for historical background. This does not mean that the experience should not be educational, just that it should not be exclusively educational. Games should appear as a game and so should include game aspects such as different levels of challenge when they design new visitors' experiences. At the same time, if the experience requires too much investment of effort, participants will grow tired or distracted, and the experience will lose relevance and value (Simon, 2016). Thus, the experience should be challenging but easy to interact with or, in traditional HCI terms, highly usable.

It is tempting for museums to use digital entertainment technologies to compete with other forms of increasingly widespread, often digital, entertainment. In fulfilling the other, educational, aspect of museums' mission, it is useful to pick a

clear message or information to be communicated and then to identify an appropriate technology to deliver it. However, if visitors are not familiar with the technology, they may become frustrated. Even if visitors seem engaged, their attention may be focused on the technology rather than on the content the museum is trying to share. For example, the fourth game developed during GameTale was very entertaining and based around one clear message: the brooch was missing its gems, so let's collect them to restore it to its original condition. Unfortunately, while the game concept itself was very effective, the technology was unfamiliar and too complicated to be experienced as highly usable, and ultimately monopolized the players' attention.

RtG involves participants directly in the research process, so that is possible to gain insights into players' actual experience, test hypotheses and discover new solutions. RtG offers a playground to test new designs and reduces the risk of failing when developing new experiences. RtG is a collaborative approach where participants can express themselves in a safe environment. In this way, researchers can connect and communicate effectively with them. While traditional methods such as interviews and questionnaires usually do not provide participants with intrinsic value, RtG can be an engaging and educational activity in its own right. Participants enjoyed both making and playing games, but also learned more about Dyrham Park with Tell-A-Dyrham-Tale and discovered new artefacts through GameTale.

4.6.1 Guidelines to Conduct Research through Games

In this chapter I propose my investigation of RtG, a method of research through game play and game design. A few studies propose playing games as a method to collect data for purposes other than the game itself (Adamou, 2011; Carter et al., 2014) and using game jams as a research method to understand users (Deen et al., 2014). However, there is little published research and there is not as yet an established methodology. Moreover, research on games and game jams as research and design methods do not include the museum context.

In this chapter, I seek to lay some of the foundation for the establishment of such a methodology by the research community. Based on the investigation of participants making and playing games, I summarize recommendations on how to run RtG studies and gather data. As a research method, RtG should provide new information and knowledge to solve specific issues and inform other contexts. Moreover, since the method is based on game-based applications, RtG should provide an entertaining **game-like experience** to its participants. This gameful approach needs to be supported by **transparent and reliable data collection**.

In order to solve specific issues and inform other contexts, RtG must **balance constraints and freedom**. Constraints are key to directing data collection towards what the researchers are actually interested in investigating. For example, the theme of a game jam and the rules of a game can provide constraints such as a theme around which to develop the games. Freedom allows players creativity and

self-expression. In RtG, therefore, the tension between constraints and freedom must be resolved in a way that provides both effective gameplay, with all the characteristics that demands, and effective data collection. Finally, as RtG is a research method and aims to inform other contexts, it is critical to have robust and reliable mechanisms through which to **share outcomes**.

Offer "the Game" Experience

It may seem obvious but a game-based method such as RtG should be entertaining. If it is not, then it is highly unlikely to serve its purpose. While games are deployed to collect data, so for research purposes, the experience itself should still be engaging for the players. The game *making* activity should be organized as a real game jam or hackathon. In game *playing*, the game should look and feel like a game. For instance, *Tell-A-Dyrham-Tale* is a storytelling game. In order to design it, I drew on well-established card games and storytelling games such as *Once Upon a Time*. Thus, typical game elements such as competition and challenge were used. Moreover, I have put considerable effort into testing that all these components worked well *as a game*.

Professionally made games are always tested to ensure good playability before publishing them. In the same way, researchers should test the game-based applications they intend to use for RtG. For example, *Tell-A-Dyrham-Tale* was tested multiple times before playing it with the public, allowing us to refine and improve the game. GameTale was based on previous experience with other game-based events such as the Global Game Jam[21] and Museomix[22]. Moreover, during GameTale, Team 2 user-tested their developing game within the 2 days of the game jam. As a result of this testing, they refined the aesthetic and game play, improving the rules and making the game smoother. They also achieved an appropriate level of challenge: players had to think about a strategy but it was not too overwhelming. Thus, both *Tell-A-Dyrham-Tale* and game 2 of GameTale worked well as a game, which is the attribute that appears to be the biggest motivator for players (Lieberoth, 2014).

Table 14: Methods I used to collect data before, during and after RtG. I indicated whether each tool was used with participants playing (Tell-A-Dyrham-Tale) or making games (GameTale): I used ✓if the tool was used and ✗if the tool was not used.

Method	When	Playing	Making
Online survey	Before (registration)	✗	✓
Short interviews	During (breaks)	✗	✓
Short interviews	After	✓	✓
Video presentations	During (evening)	✗	✓
Direct observation	During	✓	✓
Audio recording	During	✓	✗
Photos	During	✓	✓

[21] *https://globalgamejam.org/*
[22] *http://www.museomix.org/en/*

Make Data Collection Transparent and Reliable

In offering a game-like experience, the collection of data should be as discreet as possible, becoming almost invisible in order not to disrupt the players' experience. For instance, each Tell-A-Dyrham-Tale session was audio-recorded and players were informed of this. However, the recording device was located out of sight and the researcher never interacted with it during the game. As a consequence, players did not appear to be influenced by the audio recording. Also, photos were taken only at the end of the game. Players were simply asked to leave all the cards on the table as they were in order to provide an overview of all the cards used. Another option would be to install a camera on the ceiling over the table to record the game sessions but this was not possible for us in this case as we were playing inside an historic building. The process was the same for each game session: audio-recording and taking photos of the tabletop.

The data collection during GameTale was also designed not to disturb the teams engaged in the event. The game jam timeframe is short so participants could not be interrupted for long. This precludes techniques such as lengthy interviews or focus groups. Thus, the data collection relied on observations and short semi-structured interviews, which were run during the breaks. This was effective in gathering data and did not seem to disrupt the workflow and concentration of the designers. They remained focused on their games and keeping to the same schedule helped them become accustomed to the routine. However, because the interviews are so short, it is necessary to select very carefully which questions to ask and so to have a very clear idea of what we wish to investigate.

Moreover, different kinds of data can be collected as the teams and games evolve over the course of a game jam. For example, day 1 of GameTale was more focused on defining the game concept and basics such as choosing game artefacts, while the second day was more focused on game play design and development. Thus, we could ask questions about game concepts during day one while focusing on game development on day 2. Since participants can change their ideas during the course of a game jam, I recommend never changing questions that are core or fundamental to the research throughout the event. The core questions will depend on the particular research questions of interest. In the case of GameTale, we always asked what role the museum artefact had within the game because this was of central interest to us in the context of designing for museum visitor experiences.

Data collection should be *reliable*. This means that data collection should be well-documented, generalizable and consistent during RtG. For example, maintain a consistent methodology through the entire study, documenting which questions you ask, which data you are collecting and how, e.g. using video and audio recordings. If multiple researchers are collecting data, ensure they are consistent, so that they ask the same questions and use the same tools. For example, during GameTale a checklists with a set of main questions was distributed to each interviewer and used to interview participants. It is fundamental to train the researchers involved so that they know which information we wish to gain and how.

For Tell-A-Dyrham-Tale, one researcher was enough to act as Game Master and collect data because the game involved small groups, up to 5 players, and was also audio-recorded. Each game session was run by the same researcher four times in a controlled environment, at the University of Bath, before playing the game with real visitors in the field. Thus, the researcher was able to test both gameplay and data collection (e.g. which photos to take and when) multiple times before bringing the game to Dyrham Park.

Throughout GameTale, the interview data was captured manually by interviewers. One interviewer for every 3 or 4 teams was sufficient to achieve an acceptable quantity and quality of data for the purpose of this research. However, experience of the subsequent showcase suggests that it would be helpful to involve more interviewers to gather participant feedback over the period of the showcase. Interviewers were briefed before the event and then again before each interview session. We also provided each interviewer with the same checklist of questions, which proved to be an effective and efficient tool, allowing fast and focused recording of responses to the research questions. In order for these data to be reliable, different interviewers must be consistent in asking the same questions and recording information related to the same topics. Hence it is important to use common checklists and to train the interviewers collectively. The interviewers received brief refresher trainings before each interview session. This as good practice in addition to full training on the day before the event. Nevertheless, despite consistent training each interviewer will inevitably notice or emphasize different aspects or nuances of the game play or game creation. Audio recording therefore provides an important and consistent supplementary record of the raw data.

Balance freedom and constraints

The balance between freedom and constraints is complicated to achieve yet very important. An important way to achieve this balance is through game testing. Before playing *Tell-A-Dyrham-Tale* with visitors at Dyrham Park, the game was tested multiple times. As a consequence, the game play improved. For example, the auction phase became more engaging and participants particularly enjoyed the competition that developed in it. However, when using games in the context of RtG it is important to keep reflecting on how amendments to the gameplay may influence data collection. For example, additional constraints in the storytelling phase of *Tell-A-Dyrham-Tale* might increase the quality and quantity of collected data. The current game allows players to use their cards and the information displayed in any way. One constraint could be to force players to use the historical information of at least 2 of their cards as they are written. This might steer players towards telling more historically accurate stories. Further gameplay tests would confirm the effects for both researchers and players.

Game jams also have design constraints. In particular, the theme of a game jam provides direction and support innovation within the relatively brief period of a

game jam (Kultima et al., 2016). However, participants are also left with some flexibility because game jams are, after all, creative events. Again, it is crucial when using game jams in RtG to find the right balance between freedom and constraints. Through GameTale, I learned that we should have defined more explicitly and tightly our key constraint of what to do with the digitized artefacts. GameTale gave the designers a great deal of freedom, telling them simply to use at least one artefact in each game. Thus, participants could be creative and do any sort of game, including more than one object if they wanted. But in this way, the artefacts were often not at the center of the games. Instead, they ended up being just one of many game objects. Indeed, data collected during the showcase made it clear that the majority of players ultimately had little awareness of which museum artefacts were included in a game.

Constraints are important to focus game jam participants' creativity, and our ability to collect relevant data, in the direction we are interested in investigating. Since I was interested in investigating how digital artefacts can be interpreted and used in interactive museum experiences, then I could have provided a much tighter constraint, for example by telling them to choose just one artefact and that one artefact was the theme of their game. In this way, I would have forced participants to develop the game around one object and I could have gained more focused data to meet the research objective of understanding how to share digital artefacts with the public through interactive experiences.

Share outcomes

Sharing results is an important aspect of research. Thus, we suggest sharing the documentation of the methods, including for example photos and audio recordings and also the games played by or made by users during the study. As recommended above, an RtG study should be well documented to facilitate generalizability and reusability. This implies that the data collected as well as the methods used should be shared so that other researchers can make use of the data and/or replicate the study.

A template of Tell-A-Dyrham-Tale is available online at *https://goo.gl/6vh83e*. The file includes blank cards that can be customized by other researchers, game items (e.g. game coins) and a rulebook. By making these resources accessible, the game can be reused and repurposed by other researchers.

If you organize a game jam for RtG, I recommend collecting all the games developed and, if possible, publishing them online to make them more widely accessible. Publishing them in this way can not only make the games available to a wider audience but, given appropriate data collection mechanisms, can facilitate the collection of potentially large scale additional data. For instance, the Wellcome Trust published their game "High Tea" in online games portals and then analysed players' comments in the forums. In this way, they collected an impressive range of data from players, for example on the game design, the play experience and the game aesthetics (Birchall and Henson, 2011).

Data can be also automatically collected through the game. For example, Sea Hero Quest is available online through both Google Play Store and Apple's App Store, collecting over 80,000 ratings from the former[23] and over 2,000 from the latter[24]. Hugo Spiers from University College London (UCL), who worked at the project, noted how "in my research team, I could only test about 200 people a year, and that's working hard. But last night I tested 200 people in 1 minute with this game" (Morgan, 2016).

4.7 Summary

In this chapter, I have proposed and investigated the use of RtG as a *research method that employs game creation and game play to collect information, create knowledge to solve problems, and inform future user experiences that are both meaningful and entertaining*. Although publications emphasizing the value of games and game jams for research already exist, they are still few and mostly brief publications. The field is new and lacking an established methodology. Thus, I contributed to the development of the field and methodology by providing a comprehensive overview of RtG, and building on more established concepts from game and design research.

Through our case studies, I have also investigated how gameful experiences can be used to collect data and produce new knowledge to answer questions relevant to the museum context. In particular, RtG helps to connect with players, gaining information from and about them. I could understand how participants perceive a specific topic; in our case studies they happen to be digital heritage artefacts. I could learn what our target audience is interested in and how best to communicate with them.

Through **TADT** (Section 4.4) I gained knowledge to answer two main questions: (1) Which bits of narrative are more appealing to visitors? (2) How do visitors perceive different narrative genres? Visitors were interested in discovering the origin of museum objects and learning about people who lived in the historical property. In particular, players were curious about the women, what they did and how they lived. Moreover, players apparently considered historical information not sufficiently engaging and added fictional elements (e.g. mystery and fantasy) to make their stories more appealing.

Through **GT** (Section 4.5) I gained knowledge to answer two main questions: (1) How do participants perceive and interpret digital artefacts? (2) How do participants perceive digital artefacts within games? Participants demonstrated an increasing interest in the artefacts and their history while they were designing the games. At the end, 9 games were developed. However, only one game was strongly based on the historical background of the object while another was educative and tried to deliver information regarding the artefacts. The other games used the

[23] https://play.google.com/store/apps/details?id=com.glitchers.catchhero&hl=it
[24] https://itunes.apple.com/gb/app/sea-hero-quest/id1034383306?mt=8

artefacts mostly as a game component. As a result, visitors find the games generally engaging but did not perceived the objects in the games as artefacts.

Based on the experience from the two studies, I can also provide an initial set of guidelines to set up RtG. In particular, I identified the following three **key points**:

(1) **Constraints** can be delivered as game play rules or the theme of game jam. They are probably the most critical component of RtG. To be effective, the constraints based on the context and requirements must be sufficiently specific to frame the research questions and to allow both players and designers just enough freedom to be creative but not so much that they diverge from the particular design and research requirements.

(2) RtG is an **entertaining and educational** experience in its own right. That is, you are developing a game or organizing a game jam, not just running a study. You are providing a gameful experience. In order to achieve this, the researcher must herself become experienced with games, game jams and other game-based activities. Take inspiration from professionally made games and events. Don't be afraid to make the game challenging and competitive, as real games are in order to be engaging.

(3) Always **test** and run pilot sessions and listen to your game players and game creators. When you can, invite experienced game jammers and gamers to play the game or pilot the game jam. Matt Leacock, one of tabletop gaming's most successful designers, also suggests how "part of the reason for its (the game Pandemic) success is I played it with just a tremendous amount of people who all gave a lot of really good feedback".[25]

In this chapter I was able to provide a set of guidelines to collect data from and about visitors to inform the design of new interactive experiences that are relevant and meaningful for the public. While this gives me the capacity to design authentic and entertaining experiences, I cannot make sure that the final product meets those requirements. I am missing a tool to evaluate whether the new experience designed is indeed perceived by the public as authentic and entertaining. Visitors' perception of the museum experience is very subjective because it is dictated by personal background and feelings.

Both perception of authenticity and entertainment are strongly influenced by emotions (Chapter 2). For example, an object or place might catch and hold a visitors' attention because of a personal connection. The visitor creates a new meaning associated to that object or place. This special connection stimulates strong emotions, which could be nostalgia, sadness, or happiness. As a consequence, the experience is perceived as authentic, genuine, and engaging. Next chapter (Chapter 5) describes which tools have been developed to evaluate users' feelings and affective states. I then propose our tool to access visitors' perception of museums' experiences in the digital age.

[25] http://www.eurogamer.net/articles/2016-05-04-the-making-of-pandemic-the-board-game-that-went-viral

Chapter 5

Evaluation of Visitors' Experience in the Digital Museum

As society is continuously changing, there is a growing pressure for museums to understand their visitors (Davidson et al., 2015; Scott, 2011) in order to design more satisfying experiences and deeper connections (Black, 2012). Since museums are moving towards a more visitors-focused approach, visitors' studies are increasingly systematic and professional (Davidson et al., 2015). However, traditional means to evaluate museum experiences are not always accessible or appealing. It can be difficult to involve visitors, as those methods are time consuming and can disrupt the museum experience (Foster, 2008). In general, "studying human activity is neither simple nor easy" (Hein, 1998, p. 133), even more so in museums, which are emotionally driven sites where people's behaviour is not strictly objective and rational. It is a more *experiential* approach where human behaviour is subjective and influenced by emotions, and where each visitors' experience is unique (Brent Ritchie et al., 2011). As determined in Chapter 2, personal feelings also determine how authenticity and entertainment are perceived. In this context, it is particularly important for museum to understand which emotions are elicited during the visit.

Non-verbal instruments such as Emocards (Desmet et al., 2015) and PrEmo (Desmet, 2005) are particularly efficient to measure both general and specific emotions. Non-verbal instruments are also cross-cultural (Reijneveld et al., 2003), which particularly fit museums need to approach people with diverse cultural backgrounds. Although those non-verbal tools are not always intuitive (Caicedo and Van Beuzekom, 2006), graphic representations of emotional states are increasingly popular in everyday life (Gülşen, 2016), which means they are likely to be familiar to potential participants and museum visitors. We call those graphic symbols Emoji, from the Japanese *e* (picture) and *moji* (character) (Gülşen, 2016; Rodrigues et al., 2017). Emoji are growing in types and number (Gülşen, 2016) and are effectively becoming part of our language, in particular our digital language. Indeed, for the first time the Oxford Word of the Year in 2015 was an Emoji, "*Tears of Joy*" (Oxford Dictionaries, 2015). As Emoji are becoming increasingly relevant in contemporary society, researchers started to investigate them, looking at how to measure and categorize them (Boia et al., 2013; Rodrigues et al., 2017), and sometimes even using them for evaluation studies. For example, Emoji have been used as a design method

for self-reporting emotions (Desmet et al., 2015). Despite this, the use of Emoji for evaluation purposes in museums is very limited and used to pictorially enhance traditional questionnaire scales for younger users (Analysis, 2010)

Through this chapter, I first draw an overview of how visitors are evaluated in museum (Section 5.1.1), and subsequently focus on how emotions have been investigated in multiple fields (Section 5.1.2). Then, I investigate a new evaluation toolkit that uses Emoji to evaluate visitors' experience through museum exhibits (Section 5.2). Usually Emoji-based surveys use only 3 or 4 facial expressions (Happy, unhappy, and neutral). Moreover, in museums this method is deployed just with children. Instead, I designed *a set of Emoji* to capture a wide range of emotional responses from visitors. Our Emoji are based on sets used in popular social networks such as Facebook Messenger and WhatsApp (see Emojipedia[26]). Illustrations and pictures of faces are not always clear (Caicedo and Van Beuzekom, 2006) and can be too abstract to be intuitive (Bradley and Lang, 1994). Therefore, I ran a series of word-association tasks to investigate whether the images clearly expressed specific feelings or were too ambiguous (Section 5.3). I then developed a series of Emoji-based tools to further validate the meaning associated with each Emoji (Section 5.4 and 5.5). I also used Emoji to evaluate visitors' experience with different interactive exhibitions, so we could access whether Emoji-based surveys are intuitive, rapid and non-disruptive. I could infer how Emoji can be used to understand visitors' affective experience (Section 5.6). Thus, our second major contribution is a discussion over *how Emoji can be used to evaluate visitors' emotions*.

5.1 Measuring Visitors' Experience

Visitors' perception of the museum experience is very personal, influenced by a series of factors such as expectations, motivations and subjective feelings (Bryce et al., 2014; de Rojas and Camarero, 2008). Emotions are important factors to take into consideration as they are a product of our interactions (Boehner et al., 2007), they influence users experience (Isomursu et al., 2007) and motivate satisfaction (Del Chiappa et al., 2014). At the end, emotions appear to influence people's experiences even more than cognitive aspects (Del Chiappa et al., 2014). However, feelings are subjective and intangible, so they are challenging to evaluate (Scott, 2011). They cannot be easily verbalized (Reijneveld et al., 2003), they change quickly according to the situation and they are forgotten even faster (Boehner et al., 2007; Isomursu et al., 2007). This makes it hard to capture them through language-based means such as questionnaires and interviews. Observational methods such as direct observation have been also used in museums, but it is complicated to have a deeper understanding of visitors' feelings just by observing them: "meaning is complex and one person's observable, objective behaviour turns out to be another person's assumption about an unobservable state of mind" (Hein, 1998, p. 101) In alternative, emotions have also been evaluated by analysing bodily reactions such as heart rate

[26] *http://emojipedia.blogspot.it/*

and pupil dilatation (Harmon-Jones et al., 2016; Reijneveld et al., 2003). However, physical reactions usually measure just basic emotions - such as anger and joy - and do not reveal complex feelings (Reijneveld et al., 2003). And often museums do not posses the necessary instruments to record those body activities. Moreover, every person expresses emotions in different ways, depending on his/her personality and cultural background. For example, a recent study showed differences in how facial expressions of emotion are perceived by different cultural groups, such as Western Caucasian and East Asian (Jack et al., 2012).

5.1.1 Techniques for Conducting Visitor Studies

Visitor studies is a very broad term that encapsulates the research and evaluation of museums and the public they are serving or planning to serve (Davidson et al., 2015). They are carried out for a series of reasons. For instance, collected data can justify the value of the museum and support the design of future exhibitions as well as corroborate the effectiveness of existing exhibitions (Davidson et al., 2015).

During the last couple of decades research in the field concentrated on how people interact with museums (Davidson et al., 2015) and because of the growing importance of visitors' studies, research has been carried out more systematically, with museums even reaching out to professional agencies to analyse their visitors.

Thus, visitor studies is now a broad field of research, which includes both qualitative and quantitative methods (Davidson et al., 2015; Foster, 2008). Hein (Hein, 1998) divided those methods in three main categories: (1) Observation Methods; (2) language-based methods; (3) Other/Combined methods.

Museums carry out visitor studies for a number of reasons. For instance, evaluation data can justify the value of the museum and support the design of future exhibitions, as well as corroborate the effectiveness of existing exhibitions (Davidson et al., 2015). Recent research has concentrated on how people interact with museum exhibits and, because of the growing importance of visitors' studies, has been carried out using systematic empirical techniques (e.g. Ichino et al., 2013; Ichino et al., 2016), with museums even reaching out to professional agencies to analyze their visitors (Davidson et al., 2015). Recent evaluation guidelines from cultural institutions such as the Smithsonian (Visitor Evaluation Guidelines, 2015) and the East of England Museum Hub (Foster, 2008) indicate that the most used methods were and still are observation, questionnaires and interviews. Thus, museums utilize a combination of qualitative and quantitative methods (Davidson et al., 2015; Foster, 2008). Hein (1998) divided those methods into three main categories: (1) *observational methods*; (2) *language-based methods*; and (3) *other methods*. Those categories allow us to contextualize the Emoji toolkit in the realm of visitors' studies, highlighting contrasts and relationships with pre-existing methods.

Observational Methods. Researchers observe visitors and record their movements and actions within the museum. Originally, an observer would follow the visitors, drawing their path on a paper form including a floor plan of the exhibit. More recently, new technologies such as Indoor location sensors (Lanir et al., 2014) and Infrared sensors (Fairfax et al., 2014) allow for a more automated system to track visitors patterns as well as attraction and holding power. Attraction power indicated whether a person stopped or not in front of an exhibit. While holding time indicates the average time a person spend in front of an exhibit. Although both attraction and holding power are both considered measures of visitors' engagement, it is complicated to have a deeper understanding of visitors' experience, feelings and pedagogical outcomes (e.g. if they remember a specific concept) just by observing them: "meaning is complex and one person's observable, objective behaviour turns out to be another person's assumption about an unobservable state of mind" (Hein, 1998, p. 101). And since "researchers … are limited by what they can actually see" (Hein, 1998, p. 101), interviews are often run to support data collection from direct observation. Moreover, visitors observation require skills and planning, and even with lot of experience, it can still be intrusive (Foster, 2008).

Language-based methods. These techniques involve collecting written and/or verbal feedback from museum visitors about their experience. There are many different types of language-based methods, including comments cards and participant journals (Foster, 2008). However, questionnaires and interviews were and still are the most common language-based tool used to evaluate visitors (Davidson et al., 2015; Hein, 1998). In particular, surveys are easy to distribute and are less time consuming for both museum staff and visitors than for example interviews or focus groups. And they can provide information about what people think about a specific topic, while interviews raise concerns about "subjectivity" and limited capacity of participants to be reflective. Already from the first visitors studies back in 1932 (Murray, 1932), it was noted that visitors mostly commented their experience with just "interesting" or "very interesting". And more recent studies seems to confirm that personal feelings are difficult to verbalize (Scott, 2011) Although answers are generally honest, that does not mean that they say matches what they feel. Mostly, respondents try to please and would say what they think the interviewer would like to hear: "visitors, like other respondents, are eager to please, and tend to give what they consider an 'acceptable' response or what they think the interviewer wants to hear" (Hein, 1998, p. 124). And "visitors' responses are less likely to match what is in their mind as we move from facts, to beliefs to feelings, and increasingly less likely to be accurate as the events discussed are (…) in the past" (Hein, 1998, p. 117). Moreover, with both questionnaires and interviews, it is not always easy to convince people to actually participate and provide data. Only the most motivated people decide to complete surveys, and they are usually the one who had either extremely positive or negative experiences (Foster, 2008). Thus, questionnaires might provide just a limited range of responses and views. It is also

very difficult to design good questions that are clear and not open to interpretation. And while data from surveys tends to be more objective than for example from interviews, answers are not always candid (Benedek and Miner, 2002). At the end, interviews are often needed to provide more in-depth responses. However, both data collection and analysis is time consuming and require training. Focus groups are even more time consuming than interviews, for both researchers and participants, which is probably why it is particularly difficult to recruit participants for it (Foster, 2008).

Other Methods and Combinations. Other methods include creative approaches such as drawing or taking pictures. For example, the British Postal Museum & Archive used a series of creative drawing activities to evaluate visitors' learning outcome (Conklin et al., 2014). Another system is to record and transcribe visitors' conversations and comments by placing microphones on displays. This is usually unobtrusive but visitors need to be aware of the recording devices and consent to be recorded. Moreover, transcribing is time consuming and we could have many hours of random conversations to analyse.

While all the above methods are currently used in museums, recent Evaluation Guidelines from cultural institutions such as the Smithsonian (*Visitor Evaluation Guidelines*, 2015) and the East of England Museum Hub (Foster, 2008) indicate that the most used methods were and still are observation, questionnaires and interviews. Of course, all methods have their potentials but also their limitations, thus *combinations* are often preferred, so that museums tend to use more than one method at the same time. By using combination of methods, museums can cover a wider range of people and data. For example, interviews are often used to support both direct observation and questionnaires, providing more in-depth information. The British Museum uses a mix of focus groups, interviews pre and post-visit, survey post-visit, direct observation during the visit, and personal meaning maps to explore in depth visitors' behaviour and opinions (Morris Hargreaves McIntyre, 2013). Still, combinations of traditional methods provide just limited data about personal feelings and visitors' experience is strongly influenced by personal emotions, which are not easy to verbalize (Reijneveld et al., 2003) or to observe (Hein, 1998).

5.2 Investigating Emotions

Emotions are generally considered changes in conscious subjective feelings in response to an evaluation of external or internal events (Borod, 2000). More recently, Del Chiappa et al. (2014) defined emotions as affective variables elicited by an experience or by the use of a specific item. Emotion can be described in terms of expression, such as joy versus sadness, or by category, such as pleasantness versus unpleasantness. Emotions also present themselves with different levels of intensity. Intensity is defined as the degree to which emotions are experienced regardless of

valence (van Goozen et al., 1994). Valence is a characteristic often associated to emotions and it differentiates positive and negative experiences (Barrett et al., 2008, chap. 8). Although emotions do not need to have a specific valence, they can be good and bad at the same time (Barrett et al., 2008, chap. 8).

In addition, emotions can have different attributes. (de Rojas and Camarero, 2008) have identified three main attributes of emotion: (1) Physiological arousal, which considers changes of the body such as heartbeat; (2) Motor expression, indicating facial, vocal and body expressions; and (3) Subjective feeling, where subjects are aware of their emotions and can describe them. This study focuses on subjective experiences. In particular, I am interested in evaluating whether visitors are satisfied with their overall experience, focusing on affective responses to exhibits such as pleasure and anger. However, it is important to note that interactive exhibits might provoke other feelings including contemplation, dread or even discomfort, and these may be central features of the intended experience (E.g. Benford et al., 2012; Marshall et al., 2011). In addition, I am interested in capturing other meaningful qualities that exhibits might produce, such as achievement or social interaction (de Rojas and Camarero, 2008). That means that, while I am primarily interested in investigating emotions with our emoji toolkit, I do not preclude consideration of other affective states such attitudes (i.e. enduring beliefs and predispositions towards something or someone else) and personality traits (i.e. stable dispositions and behaviours typical of a person) as features of the visitor experience.

5.2.1 Measuring Subjective Experiences

Subjective experiences can be measured either using verbal or non-verbal instruments.

Verbal instruments involve a person expressing their feelings using their own words (spoken or written). Such instruments are used to measure subjective emotions and can assess any set of emotions as well as mixed emotions. However, subjective and subtle emotions are difficult to verbalize and measure with verbal questionnaires (Desmet et al., 2015; Mehrabian, 1995). Moreover, standard scales such as Likert force emotions into pre-set ranges and tend to gain positive, non-candid responses (Benedek and Miner, 2002). Mehrabian's (1995) PAD emotion scale asks individuals to break down their feelings into three abstract concepts: (1) pleasure-displeasure; (2) arousal-non-arousal; (3) dominance-submission. However, those dimensions are not always clear and easy to explain (Caicedo and Van Beuzekom, 2006).

Non-verbal instruments include tools that measure emotion through interaction with gesture, gaze and auditory stimuli. For instance, Ramanarayanan et al. (2015) used a variety of equipment and software tools including Microsoft Kinect to evaluate the quality of public presentations in relation to speech, face, emotion and body movement. Lu and Petiot (2016) used a set of auditory stimuli to convey and assess a set of emotions such as funny, serious, relaxed, and depressed. One advantage of these techniques is that they are unobtrusive as they do not require

users to verbalize their feelings. However, the technology used to sense non-verbal behaviour often has limitations. For example, Mueller and Bianchi-Berthouze (2015) noted that gesture recognition technology is still unpredictable and the set of movements and gestures cannot be predefined. Moreover, non-verbal methods cannot measure mixed emotions and their range is limited to few basic emotions (Desmet, 2005). Finally, it is not always feasible for museums to buy, install or force visitors to wear devices such as body trackers, brain or temperature sensing devices.

Examples of successful tools to *measure people's emotions* are the Geneva Emotion Wheel (Scherer, 2005) where 20 emotion families are arranged with a five degrees intensity on a circular pattern, and the Product reaction cards (Benedek and Miner, 2002), which uses a set of cards displaying a word on each. However, because of their semantic nature, neither the wheel nor the reaction cards are valid cross-culturally. For example, Caicedo and Van Beuzekom (2006) needed to translate the list of emotions in the wheel into Dutch for their fieldwork. Indeed, museum visitors may have different cultural backgrounds, ages, and learning abilities. A solution appears to be the use of pictorial representations such as cartoons and photos, as those are generally more understandable across cultures (Benedek and Miner, 2002; Desmet, 2005) and can remove the need for verbalizing (Desmet, 2005).

In particular, research has shown that representations of facial expression could communicate emotions in an effective way, sometimes even better than verbally (Bradley and Lang, 1994; Desmet, 2005). For instance, (Bradley and Lang, 1994) proposed a graphical version of Mehrabian's PAD using Manikins, a.k.a. graphic characters, and a nine-point scale to make this tool more intuitive to participants. However, the Manikins still do not differentiate emotions, and measure people's affective reaction in relation to three abstract dimensions of internal state: pleasure, arousal, and dominance. Other methods were designed for a specific target group or to investigate a limited set of emotions.

For example, the 'Smiley-o-meter' uses Emoji-style icons to evaluate children's experiences with technology (Read and MacFarlane, 2006) and Microsoft tested a questionnaire with adults using pictures of six faces as stimuli instead of words in order to get user input on intangible properties such as "desire" and "fun" (Benedek and Miner, 2002). Emofaces uses a series of female and male faces to represent emotions ranging from pleasant to unpleasant, and intense to calm (Posner et al., 2005). Emocards ask people to choose the cartoon face that better identify their experience (Desmet, 2005); and PrEmo uses a three-point scale (not-felt, light, intense) with 10 cartoon animations to represent emotions (Desmet, 2005).

This Chapter presents a set of Emoji that are intuitive for museum visitors to understand and are able to effectively capture users' emotions. Our set will be less abstract and more familiar than existing techniques, e.g. Bradley and Lang's (1994) Manikins, so that users should be able to easily infer their meaning. Moreover, researchers have found that the existing techniques are not always clear; in particular, photos of neutral faces and abstract illustrations gain the most inconsistent interpretations (Benedek and Miner, 2002; Bradley and Lang, 1994;

Caicedo and Van Beuzekom, 2006). In order to overcome this limitation, I developed a set of graphical emoji characters and ran a series of studies to validate their perceived meaning among target users. This resulted in a final set of 20 emoji for use in evaluating visitor experiences. The next section summarises the validation studies and presents final the emoji set.

5.3 Design and Validation of Emoji

Our research began by designing an initial set of 38 Emoji. Emoji are a relevant, engaging and lightweight system to collect data. (Bacon et al., 2017) suggests the use of Emoji as an alternative to text in mobile surveys to improve engagement without reducing data quality. Emoji are now part of our language (Oxford Dictionaries, 2015) and are often used to express emotions, especially via social network (Kelly and Watts, 2015; Vidal et al., 2016). For example, emoji are used to express feelings regarding food consumption (Vidal et al., 2016).

In this chapter I am investigating emoji as a mean to access visitors' emotional states, their feelings about a specific museum exhibit. In particular, I am interested in evaluating whether visitors are satisfied with their overall experience, which is made up of components such as pleasure, clear communication, achievement and social interaction (Figure 2) (Chapter 2.4). Thus, I started by designing an initial set of 26 Emoji illustrating concepts such as *Happy*, *Sad*, *Confused*, *Angry*, and *Bored*. I also created Emoji representing other affective states, such as physically or mentally *Tired*, *Achieved* (feeling like they learned something), *Enlightened* (they discover something new) or *Socially* engaged. Finally, I wanted to measure different kinds of entertainment and engagement particularly with historical content, which is why I added multiple Emoji illustrating fun and entertainment (i.e. B, B1, B2, B3, B4, B5) but I also tried to somehow portray an historic feeling (i.e. S1) and learning (i.e. S and S2) (see Appendix C).

I used a Wacom Bamboo graphic tablet and Adobe Illustrator to design these Emoji, taking inspiration from existing representations including those used in Apple[27] iOS, Facebook Messenger[28] and Skype[29]. Those Emoji are already familiar to people and hence could be used for evaluation; however, they are protected by copyright, requiring us to design our own set of Emoji for use by researchers and practitioners.

5.3.1. Methodology

As literature review suggested (Section 5.1), pictures do not always clearly depict a specific emotion (Caicedo and Van Beuzekom, 2006). Thus, we decided to

[27] *https://emojipedia.org/apple/*

[28] *https://emojipedia.org/messenger/*

[29] *https://support.skype.com/en/faq/FA12330/what-is-the-full-list-of-emoticons*

run a series of validation studies using word association tasks to investigate whether participants understood our emoji intended concept or if instead they misinterpreted the emotion I were trying to depict. In order to validate the meaning of the emoji I designed, I run two types of Word Association Tests. The first test was face-to-face, using a set of cards as stimulus. The second was digital, using an online form to present the emoji.

Word association is a well-known practice (Jung, 1910; Nielsen and Ingwersen, 1999), which consists of a person presenting a stimulus and a subject answering as quickly as possible with the first word that occurs to him/her. Word association is used efficiently to gain information about people's perceptions, emotional states, mental models and vocabulary (Nielsen and Ingwersen, 1999; Roininen et al., 2006). For example, those tasks have been used to capture meaning of icons for a graphical user interfaces (Pejtersen, 1991), and food (Roininen et al., 2006), as well as to improve image databases (Ornager, 1997). In 1987 the method was used to relate 140 paintings of an Art exhibition in Hamburger Kunsthalle (Nielsen and Ingwersen, 1999). In general, response words can effectively create a cluster of associative representations of the stimulus (Nielsen and Ingwersen, 1999).

Words association is considered a valuable method, in particular for revealing people's memories, feelings and personality (Nielsen and Ingwersen, 1999). Already at beginning of the 1900, Carl Jung theorized that people connect ideas, feelings and information by meaning of association (Jung, 1910). Through his studies, he recorded test words used, reaction time and patient response. While I decided to take a similar approach by presenting a series of stimulus, I wanted to identify the meaning of a series of images, much similarly to Pejtersen (Pejtersen, 1991). In particular, I wanted to identify which emotions each emoji elicited.

A similar approach has been already used by Rodrigues et el. (Rodrigues et al., 2017) to analyse emoticons. He developed a questionnaire including a series of Likert scales and a final open-ended question where users were required "to write the first meaning or emotion that came to their mind for each stimulus" (Rodrigues et al., 2017, p. 6). This study was evaluating whether for example each emoji was aesthetically appealing, familiar, complex or clear. An open-ended question was added in order to determine the meaning associated to each emoji. Through our two word association tasks, I aim to determine the meaning associated to each of our emoji.

Onsite Word Association Task

I ran first a word-association task to validate the meaning of 26 emoji. I printed each emoji in a card 70X95 mm. I used each of the 26 cards as a visual stimulus and asked participant to provide the first three words that come to mind, without restrictions. If they could not find a specific word, they were allowed to use a short description. Each session took maximum 10 minutes and was audio recorded.

After the first onsite test, I run a second test online. The first test

demonstrated that the meaning of some emoji was too ambiguous, meaning it was not frequently associated to any group of meaning. Learning from the results of this first word association task, I have designed new emoji to better illustrate specific emotional states (e.g. emoji B illustrating happiness). I also added a new set of emoji to express more deep and personal feeling such as worried, hopeless and proud. I did so to enable investigation of experiences with complex themes in museums, where the museum is evaluating if the user is enjoying an interactive kiosk but also whether the experience itself is having some deeper impact. Thus, I used this second test to confirm the perceived meaning of emoji from the first test as well as to validate new emoji.

Online Word Association Task

I developed an online Word Association test using Google Form and I used 25 Emoji as stimuli, including 7 emoji from the first task and 18 new emoji. The survey showed the Emoji one after another in a random order and asked participants to write down as quickly as possible the first word or combination of words that occurs to their mind.

5.3.2 Participants

I had a total of 47 participants between the two tasks. 12 people aged between 20 and 35 years old were interviewed during the first onsite task. 35 participants, aged 18 to 65 did the online task. Participants were recruited through University mailing lists.

5.3.3 Data Analysis

I collected the words associated with each Emoji and grouped them for affinity. Each group contained synonymous and words that indicated similar concepts. I called these '*groups of meaning*'. In total, 45 groups of meaning were found (see Appendix E).

Then, an Excel file was created including four columns. The first column included the stimulus, so the letters of each emoji tested (e.g. A, B, C, etc). The second column included the words associated to each stimulus. A third column indicated to which group of meaning the word belonged to. The fourth and last column indicated whether the word was originated through the onsite or online task.

The frequency of use of each group of meaning was calculated using R, a software environment for statistical computing[30]. The frequency was determined by counting how many times the same group of meaning was associated with the same emoji. Since the sample was small, a 95% confidence interval was calculated in order to provide a range of values for each frequency (see Appendix F for onsite task and Appendix G for online task). I have also created a set of words clouds to form a

[30] https://www.r-project.org/

general impression about the words used and their frequency (see Appendix H).

Table 15: List of validated emoji with their meaning.

	Emoji	Meaning		Emoji	Meaning
A		Angry, disappointed	**Q**		Friends, harmony
B		Happy, satisfied	**Q1**		Friends, happiness
E		Proud, winner	**R**		Idea, discovery
F		Smug, proud	**S**		Achieved, educated
H		Sad	**T**		Thumbs down, bad
L		Worried, apprehensive	**U**		Fear, shock
M		Angry, furious	**U1**		Scared
N		Bored, tired	**V**		Tired, sick
O		Confused	**W**		Wow, surprise
P		Confused	**Y**		Thumbs up, good

5.3.4 Results

Of the 43 emoji I tested, 20 were more frequently associated to a specific meaning (see Table 15), while 23 emoji were less frequently associated to a specific group of meaning or were frequently associated with different meanings. Other emoji were instead associated to group of meanings that I was not interested in evaluating in the museum context. This was due to the fact that participants could associate any word. For example, group 17 gathered together words related to deal and handshake, group 27 word related to child and toddler, and group 44 words related to bluff and gamble.

Findings from the Onsite Task

Of the 25 emoji tested, 20 were frequently associated with one or more group of meaning while 6 were either less frequently or never associated with a particular meaning (see Appendix F).

Surprisingly, emoji C, which is based on the commonly know Neutral face emoji (e.g. see emojipedia[31] for messenger or Apple), was less frequently associated with the word neutral and was instead associated with a variety of different groups

[31] *https://emojipedia.org/*

of meaning. Although two participants connected emoji C with the word apathy and one person to emotionless, others used very different words, including thinking, sceptical, surprised, disappointed, sadness, thoughtful, scared, smiling, contemplating and interested.

In some cases, emoji were frequently associated with groups of meaning that were different but related. For example, emoji N was frequently associated with both tired (CI = 0.35, 0.69) and bored (CI = 0.06,0.32). Two participants even used both words to define it. While the two terms describe different states, a person can be very tired about something, in other words bored. Similarly, V was connected with both sick (CI = 0.1, 0.39) and tired (CI = 0.18,0.5). Sick and tired can be also related to each other in a similar manner. For instance, a person can "be sick and tired of (something)", which means "thoroughly fatigued, annoyed or bored"[32].

In other cases, two emoji were frequently associated with the same group of meaning. For example, both S and S2 were connected with clever and educated. However, S was associated with educated and achieved more frequently (18 times out of 35) (CI = 0.32, 0.67). Moreover, S was also linked with the concept of proud. Since I was particularly interested in illustrating a feeling of achievement because of some form of educational outcome, S that was also frequently associated with educated and proud was further tested in the second task, while S2 was not. A (CI = 0.14,0.45), A1 (CI = 0.27,0.61) and A3 (CI = 0.14,0.45) were each frequently associated with the concept of anger. However, A was also frequently associated with the concept of sadness. Moreover, A1 was frequently associated with greedy and A2 with impatient, two group of meaning I was not interested in evaluating in the museum context.

With emoji B1, B2, and B3 I was investigating different depictions of entertaining and happiness. However, Emoji B1 is associated with a specific kind of entertaining such as 3D, and thus can be probably used to evaluate Virtual or Augmented experiences. Emoji B2 was associated with fun but also clowns and hospitals. None of these emoji tested in this task was frequently associated with the concept of happiness. B3 was more frequently associated with the meaning of happiness (CI = 0.12, 0.42) but it was also frequently associated with the word 'tooth' or with the concept of child (CI = 0.1, 0.38). B3 displayed a smiley face with big teeth. Thus, I created a new emoji to illustrate happiness with a simple smiley face. In other words, the new emoji replicated B3 without teeth or B1 3D glasses. The new emoji was tested during the second task.

Finally, 7 emoji were associated with one particular group of meaning: B4 was linked to greed for money, B5 with bluff and gaming, G1 with relax, Q1 with friendship, S1 with historical, 0 with confusion, and R with idea and enlightenment. However, I was not interested in illustrating greed or bluff. Moreover, S1 was associated with a variety of historical periods and characters more that a general idea of historical authenticity, which is the concept I was instead interested in illustrating with this particular emoji. Therefore, B4, B5, and S1 were not further

[32] *https://en.oxforddictionaries.com/definition/sick_and_tired_of*

tested.

In conclusion, only 7 emoji out of 25 were more frequently associated with affective states (i.e. group of meanings) I was interested in illustrating: angry (emoji A), sad (emoji E), confused (emoji I), bored (emoji H), enlightened (emoji R), achieved (emoji O), and tired (emoji V). These 7 emoji were also investigated in the second association task in order to further validate their meaning.

Findings from the Online Task

7 out of the 25 Emoji tested in this second task were frequently associated to one specific group of meaning (see Appendix G): emoji L was frequently associated with the concept of apprehension (CI = 0.26, 0.6), R with idea and enlightenment (CI = 0.53, 0.85), Q with friendship, T with dislike (a.k.a. thumbs down) (CI = 0.42, 0.76), Y with like (a.k.a. thumbs up) (CI = 0.44, 0.78), and W with surprise (CI = 0.66, 0.93).

In some cases, two emoji were frequently associated to the same group of meaning. For instance, both emoji O (CI = 0.59, 0.89) and P (CI = 0.5, 0.83) were both frequently associated with the concept of confusion. This suggests that they can be equally used to illustrate confusion. Moreover, emoji U (CI = 0.21, 0.55) and U1 (CI = 0.31, 0.66) were both associated with scared. However, U1 was also frequently associated with surprised. This could suggest that emoji U was related to fear while U1 was more associated with a shock. Emoji E (CI = 0.26, 0.6) and F (CI = 0.16, 0.49) were frequently associated to proud and satisfied. However, emoji E was also frequently associated to smirk while emoji F to winner. Therefore, emoji E could be identified with maliciously proud while F with proud to have achieved or won something.

Emoji A (CI = 0.69, 0.95) and M (CI = 0.47, 0.8) were both perceived as angry. However, M was also frequently associated with furious and with a more physical action, a fight. The Emoji representing social behaviour was one of the most complicate to depict. Both emoji Q1 (CI = 0.27, 0.61) from the first onsite task and emoji Q (CI = 0.33, 0.68) from this second online task were frequently associated with happiness and **friendship**. However, Emoji Q was also frequently associated solidarity and harmony (CI = 0.14, 0.46). Thus, the two emoji could illustrate different forms of friendship and partnership. Q1 could illustrate friendship and intimacy, while Q could illustrate tolerance and fraternity. If this is confirmed, then emoji Q could help measure visitors' emotional states regarding dark heritage and difficult topics like wars and immigration. Further studies are due to determine whether emoji Q and Q1 could also illustrate form of social interaction.

In some other cases, two different groups of meaning were frequently associated to the same emoji. For example, emoji V was frequently associated with sick (CI = 0.31, 0.66) but also with tired (CI = 0.1, 0.4). Emoji N was frequently associated with both tiredness (CI = 036, 0.71) and bored (CI = 0.23, 0.57). This could suggest that both emoji could illustrate tiredness but for different reasons. I assume that this specific Emoji convey a sense of mental fatigue and boredom, while Emoji V seems to illustrate a physical weakness, a level of sickness. Moreover, different

emoji were associated to happiness and **sadness**. Emoji H was more frequently associated with "Sad" in this test (CI = 0.56, 0.87) as we all as the previous one. In this second test, emoji H was also associated with upset. Emoji L was also frequently associated with sadness but it was more frequently associated with the group of meaning illustrating apprehension (CI = 0.1, 0.4). While both terms illustrate some level of sorrow, I assume emoji H to illustrate sadness and emoji L worry.

In the first onsite task the group of meaning including **happiness** was not frequently associated with any emoji. The first test included a smiling Emoji with small teeth (i.e. B3). This was meant to represent happiness. However, this Emoji was strongly associated with "Child" as well, indicating childish fun. While emoji B1 was associated with fun and 3D rather than happiness. Therefore, in this second test we tried to delete the teeth and proposed a simple smiling face (i.e. B). As a result, emoji B was frequently associated with happy (CI = 0.47, 0.8) and never to 3D (emoji B1) or child (emoji B3). Emoji I was also frequently associated with happiness but it was also frequently associated with sun. Thus, I assume emoji B to illustrate happiness.

Finally, emoji C was associated to **neutral** more frequently than during the first task but it was also frequently associated to a variety of other terms that were not part of any particular group of meaning. Since people frequently associated emoji C to a variety of meanings, this emoji could not be validated.

5.3.5 Notes on Validation of Emoji

Both paper-based and digital validation tests resulted useful to provide the perceived meaning of each Emoji. The online test took slightly longer to prepare than the onside one, because the Google Form needed to be set up. But while the process for both was still not particularly time consuming, the online form was able to reach more people in less time. It also created automatically an Excel Sheet, which made data easier and faster to analyse than with the paper version where audio recordings of the interviews needed to be analysed and transcribe. Moreover, the paper version asked for the first 3 words that come to mind while in the digital survey asked for just 1 word. Some Emoji like the ones illustrating happiness and sadness were used in both tests and the results did not differ. Thus, the most efficient and rapid system to validate Emoji appears to be as online survey asking just for 1 word or meaning. This approach is consistent with previous studies involving Word Association tasks where usually a person presents a stimulus and the participants' answer with the first word that occurs to him/her.

While the word association tasks helped to determine how each Emoji was perceived, I still suggest running a comparison test as well in order to understand how people interpret Emoji when they are deployed through a survey. The comparison between interviews and our Emoji survey (Section 5.4) confirmed whether the meaning of the images actually held in the field. That is, the comparison exercise helped us understanding if the images really reflected visitors' feelings and could be used alone to access people's experience in the museum. I discovered that

basic emotions were usually perceived the same way in and out of context. For example joy/happiness and anger held the same value both in the validation and comparison test. While the comparison test provided us with a deeper understanding of more complex emotions such as physical and mental fatigue. For example, the comparison highlighted that the Emoji N representing boredom was used mostly to highlight mental fatigue, while Emoji V illustrated a more physical tiredness.

5.4 Validation of Emoji In-the-Field

20 out 25 emoji were frequently associated with one or more related groups of meaning. However, 13 out of these 20 emoji needed further validation to confirm assumptions I made based on the frequency each emoji was associated to a group of meaning. Moreover, the same Emoji can be associated with different emotions depending on how it is rendered (Miller et al., 2016). It is necessary to understand how people interpret the emoji within a survey in the context of an evaluation process, in order to fully validate their meaning. Ultimately, I wanted to demonstrate that emoji could be actually used to evaluate visitors' feelings with an interactive museum experience. Therefore, I have run two further tests, deploying Emoji-based surveys to investigate people's experience using an augmented reality sandbox (Section 5.4.1) and playing Tell-A-Dyrham-Tale (Section 5.4.2), the game previously described in chapter 4. In both cases the emoji-survey tools were compared with traditional methods: in the first case with the sandbox the emoji-survey was compared with outcomes from interviews; in the second case with Tell-A-Dyrham-Tale we used a think aloud protocol, which is traditionally used to gather data in product design and psychology.

5.4.1 Case study 1: Evaluation of an Augmented Reality (AR) Sandbox

I used the Emoji in order to evaluate how people perceived an AR Sandbox that the Department of Computer Science at the University of Bath had developed for The National Trust (NT) to commemorate the anniversary of Capability Brown (Figure 19 and 20). The project is based on the Augmented Reality Sandbox developed by Reef et al. (2014). The AR Sandbox transforms a real sandbox into an interactive virtual topography experience. Water and other kinds of terrain are projected into the sand using a data projector connected to a Microsoft Kinect 3D camera (see Figure 21 and 22). The AR sandbox allows users to create topography models by shaping real sand. The movement of the sand and its elevations are then analysed by the Kinect which can augmented in real time by an elevation colour map, topographic contour lines, and simulated water. The purpose of system teaches geographic concepts and to read a topography map.

The purpose of the Capability Brown Sandbox is to illustrate how Brown designed and implemented his landmarks, his peculiar method, and how much work the delivery of each garden required. Visitors will interact with the sand in order to

re-create a typical Brown's garden. A Microsoft Kinect was used to sense sand movement and users' gestures. On the top of the sandbox, a projector will then translate the data coming from the Kinect into a topographic map, which is a type of map characterized by quantitative representation of relief, usually using contour lines and associating different colours to different altitudes.

Figure 19: Design of the AR Sandbox

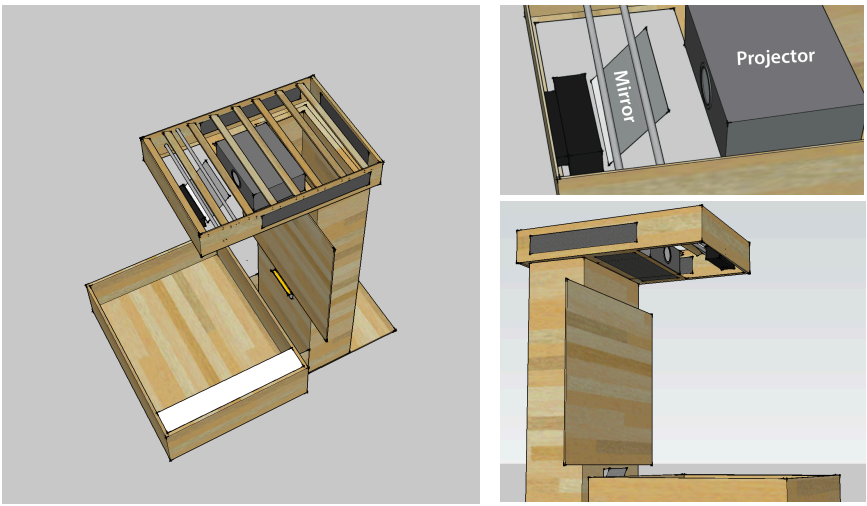


Figure 20: AR Sandbox and how it works

5.4.1.1. Methodology

An AR Sandbox was setup in a lab at the University of Bath. Each participant was given a printed copy of a topographical map and was then asked to interact with the AR Sandbox for 15 minutes. The map was the same for every participant and it

was a topographical of a hilly landscape with a lake. Firstly, they were asked to replicate the map. Lastly, they were asked to apply some changes to the map they just created in the sand. They were free to make any change in the landscape. For example, they could add another lake or a river. Soon after they interacted with the AR sandbox, each participant was asked to fill out an emoji-based survey. I also interviewed each participant, so that I could run a comparison between their comments and the Emoji they selected to see if there was any correspondence between what they said and the chosen Emoji.

Interview

Participants were interviewed soon after they interacted with the sandbox. The interviews were audio recorded. Each interview lasted for about 15 minutes and was semi-structured. The interviews were guided by a checklist of questions, ranging from learning outcomes to usability of the system. For instance, typical questions would be: Did you enjoy the experience? What did you like/not like? Was the system easy to use? Do you have any questions? Did you need any help? How did you feel during and after the task? Would you like to play with your friends?

Emoji-based survey

I also asked participants to fill out an Emoji-based survey by selecting the emoji that better illustrated their experience. In particular, I wanted to discover whether visitors enjoyed their experience or not, if they felt socially involved, if they learned something new, and so if they felt achieved or more knowledgeable. Or if instead they found the sandbox particularly complicated to use, and so if they felt tired, confused or angry. Thus, I choose 9 emoji from the list of our validated list. The emoji illustrated the following feelings: happiness, sadness, confusion, discovery, boredom, physical tiredness, educated, anger and being social (see Table 15).

Although the sandbox was tested by each participant individually, it was originally designed to be a social experience, which is why I still included an emoji illustrating social experience (i.e. emoji Q). Moreover, the emoji illustrating social involvement was the most complicated to validate via the two word association tasks (Section 5.3). Therefore, during the interview participants were asked whether they liked to play alone or they would prefer to play in company. In this way, I intended to compare their answer with whether they selected the emoji representing social involvement or not, hoping to gain additional information on how emoji Q was perceived.

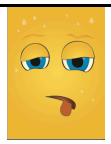
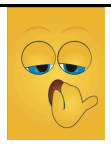
Initially, I designed the survey with the 9 Emoji on a circle, similarly to the Emotion Wheel. But I was worried this would imply some emoji was “opposite” to others, while I wanted participants to feel free to select any emoji, supporting the idea that different emotions can happen at the same time and are not necessarily exclude each other. Thus, I changed the design and I printed a paper questionnaire presenting the nine emoji in line (see Figure 21). Then, I asked participant to select

the Emoji that better illustrated their experience with the sandbox. For each Emoji, they could select 3 levels of intensity.

Data Analysis

The interviews were transcribed intro a Word document (see Appendix I). I run a qualitative content analysis of the interviews to gain a general understanding of the participants' experience with the sandbox. Then, I identified specific comments related to emotional states and subjective experiences. The outcome of the survey was transcribed into an Excel document where I have listed the participants' ID.

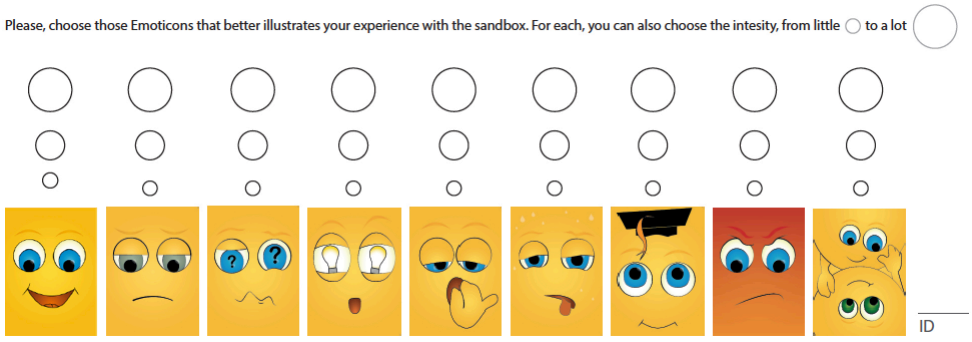
Table 16: List of Emoji used to evaluate the AR Sandbox

ID	Emoji	Meaning	ID	Emoji	Meaning
B		Happiness	V		(Physical) tiredness
H		Sadness	S		Education/Achievement
O		Confusion	A		Anger
R		Discovery	Q		Social experience/Friends
N		Boredom, (Mental) tiredness			

5.4.1.2. Participants

We had 24 participants in total, doing both interview and questionnaire. 10 of them are male and the other 14 are female. The participants varied in age from 22 to 34 years. All participants are students and member of the staff at the University of Bath. Participants were recruited through university mailing lists and word of mouth.

Figure 21: Emoji-Based Survey with the 9 Emoji



5.4.1.3. Findings

The most frequently selected Emoji were the ones representing Happiness (B), Education/achievement (S) and Discovery (R), which have been chosen respectively 21, 19 and 14 times out of 24. This was reflected during the interview where participants empathized they liked the experience, had fun and learned more about topographic maps.

Discovery was always selected with Educated, with the exception of pt 14 who chose just an average intensity of Discovery without any level of learning. Indeed, pt 14 considered the sandbox a magical experience, and although she learned something new, she also though that the sandbox "can just teach me one knowledge". Then, she added that the sandbox was "so funny … easy to use. I have enjoyed it" and she selected maximum intensity of Happiness. Similarly, pt 16 selected a minimum level of Educated and a maximum intensity of Discovery. During the interview, pt 16 stated that a textbook can give you more knowledge "but you cannot really know what is a topographical map (from a book)", suggesting that the sandbox can really give a practically idea of what a topographical map is.

While *Happiness* was the most selected Emoji (i.e. 21 out of 24), with people choosing either intensity level of 2 (*average*) or 3 (*maximum*), sadness was selected only 4 times out of 24. This general attitude was confirmed during the interviews where all participants declared that they had a pleasant experience. Usually people who selected the maximum level of Happiness choose exclusively other positive Emoji such as *Educated* and *Discovery*. However, the results did not show just extreme positive experience, rather different layers of emotions. 3 participants had also extremely negative feelings. Indeed, both pt 11 and 20 clearly stated their unhappiness during the sandbox. For example, at the beginning of the interview, pt 11 immediately stated: "It is not clear, I am really confused", adding later: "It is boring…it is just sand…it is like homework". Although pt 11 seemed to like the general idea of having something more interactive than a textbook, s/he did not

seem to appreciate our specific solution. Indeed, pt 11 selected maximum intensity of confused and angry. At the end, the participant concluded: "I felt tired because it is boring". Indeed, while maximum level of Boredom was selected, Tiredness was not selected at all, not even at a minimum level.

Pt 20 was also not happy with the overall experience. During the interview, this participant stated that although the sandbox could be "slightly more interesting" for adults a textbook would be better. Pt 20 also added that s/he had previous knowledge of topographical maps, but if s/he did not, then it would have been surely useful. Probably because of this, s/he selected a minimum level of Educated. This participant also had a series of small complains and suggestions for improvements. For instance, s/he did not like the consistency of the sand and the fact that it was always falling apart. S/he also added that the sandbox was too small, suggesting that the addition of few tangible objects or the company of friends could maybe make the experience more engaging. But at the end, the sandbox was "not that interesting". Indeed, pt 20 did not select happiness but intensity 2 of both Confusion and Boredom. A minimum intensity of Sadness was also chosen, maybe in contrast to Happiness on order to confirm the experience was not so interesting. Tiredness was not selected, and indeed during the interview the participant specifically said s/he did not feel tired.

Pt 6, who declared she was "not very excited…little bit tired", did not select anger but a minimum level of Tiredness together with boredom. In total, boredom was selected 6 times. Thus, the sandbox was not particularly engaging for 6 participants. This was confirmed during the interviews. For example, pt 4 selected a minimum intensity of Boredom and stated the sandbox "was just sand" and could be improved. Both pt 6 and 20 selected an average level of boredom and described a not particularly exciting experience during the interview. Pt 11 selected a maximum intensity of boredom and indeed described an extremely negative experience.

Other participants described mixed emotional states, experiencing fun as well as confusion and boredom. 3 times out of 24 (i.e. participants #2, 4, 22) the maximum intensity of happiness was selected together with a minimum level of boredom (i.e. emoji N) and confusion (i.e. emoji O). During the interview, pt 4 stated that the sandbox "is fine and a good learning tool, but that the colour coding (of the map) is confusing" and could be improved to better indicate "heights". However, the emoji representing boredom was selected instead of the confusion one. This could be due to the fact that the interaction itself was clear and easy to understand but that the colour mapping as slightly annoying and made the experience a little bit less engaging.

Pt 2 liked the experience and selected a maximum intensity of happiness, mainly because it "helped me understanding different altitudes". However, there was one aspect of the sandbox that was confusing: "I did not know the exact altitude of each colour". Although this issue did not seem to alter the engagement level, the participant stated that s/he did not immediately "understand what the different colours mean". At the end, pt 2 could identify the most recurring colours, such as green and blue, but was not sure for example about yellow. This was confirmed in

the Emoji-based survey as the participant select a minimal level of confusion. Pt 22 also indicated a minimum intensity of confusion, which was confirmed during the interview when the participant stated that the tasks were not so clear and could be improved. But this represented just a small issue as the participant found the experience interesting and generally easy to understand. Indeed, maximum intensity of both happiness and discovery were also selected.

In addition, pt 9, 10, 18, 19 and 21 had contrasting feelings about their experience as well. Both pt 9 and 10 liked the fact that the sandbox was interactive and found it generally clear. During the interview, pt 9 stated that the sandbox was "all clear" and "quite interesting" but a textbook would be more useful to gain a deeper understanding of the subject. At the end, pt 9 was "nor tired, nor excited", which is maybe the reason why both negative and positive emoji were selected. Pt 10 also found the system generally easy to use but emphasized that "it was not accurate", thus the interaction was not completely clear and engaging: "The problem is that I cannot compare heights". At the end, pt 10 was not particularly tired but complained about the sand stuck on his/her hands. Participants were particularly confusing about the colour mapping. For example, pt 18 stated that the sandbox was fun to interact with but probably not in the long term because the "projection took a while to update" and it made "global comparison" difficult. Pt 19 found the experience more interesting than a textbook, although the colour mapping was initially "little bit confusing". For example, it was not clear when the "blue colour became deeper". At the end, that was "not a problem" and did not affect the overall experience, as both interview and Emoji-based survey confirmed. Indeed, the Emoji indicating confusion was not selected at all. On the contrary, pt 12 selected the emoji illustrating confusion, which was never reported during the interview. The participant found the sandbox fun and definitely more interactive than a textbook, although it did not provide enough information and was "little bit messy". Pt 21 also considered the sandbox a "more direct way to understand (topographical maps)" but would like more specific guidelines, which is probably why the emoji representing confusion was selected.

5.4.2 Case study 2: Evaluation of Tell-A-Dyrham-Tale

This section presents another Emoji-based tool, a paper-cards version to evaluate a storytelling boardgame named *Tell-A-Dyrham-Tale* (TADT). TADT is a storytelling game used to share and create stories about Dyrham Park and its collection. The curator and staff of Dyrham Park provided us with a series of information about Dyrham. For example, related to Mr Blathwayt, a Politician of the British Government who built Dyrham manor in the 17th Century. Then, instead of adopting the usual approach of the curator selecting which information to present and which narrative to tell, TADT was used to involve ordinary visitors to Dyrham Park in an engaging process (see Chapter 4). As in other storytelling games, players needed to tell a good story in order to win. The stories were based on another set of cards, each containing a piece of information from the content that was initially collected from the curator of Dyrham Park. For instance, card could represent a

character, a place or an item connected with the bookcase and Dyrham Park.

5.4.2.1 Methodology

TADT was played in one of the rooms at Dyrham Park. This room had comfortable chairs, a large round table and a fireplace. Moreover, tea and cookies were offered to the players to create an informal and pleasant environment. Immediately after each game session was concluded, a brief evaluation session was carried out to investigate visitors' experience with the game. In order to evaluate TADT, I designed a set of cards - each depicting a different emoji. The same 9 Emoji used during our previous study with the AR Sandbox were used, only this time they were printed in cards measuring 70X95 mm. I were particularly interested in understanding if visitors had enjoyed the experience, if they had learned something, and if they felt their experiences to be socially engaging – or if instead they perhaps had felt confused, tired, bored. The Emoji represented both positive and negative concepts. Specifically, there were five positive values, including happiness represented by card #18 and achievement expressed by card #21. Then, there were five negative concepts, including sadness expressed by card #5 and confusion by card #14. Thus, we would expect people who felt they learned something to select Emoji #21, while people who did not understand the game or what they were supposed to do might select Emoji #14.

The evaluation of TADT as a visitor experience was deliberately brief, taking only a few minutes to avoid traditional evaluation techniques that can be slow and intrusive in the visitor experience. Thus, the evaluation needed to be fast and engaging, to be playful in a similar way to the game itself. Indeed, the emoji were printed as cards of the same dimension of the cards of TADT in order to replicate the experience users had by playing with the storytelling card game. Straight after their session of TADT, the emoji cards were placed in the centre of the table in a random order. Thus, participants were asked to select the emoji that best illustrated their personal experience with the game by placing game coins over the intended card (i.e. the same game coins used to play TADT). Participants were invited to ask questions and think aloud, so to verbalize their choices. In this way, I hoped to better understand *why* those emotions happened in the first time, for example what was enjoyable or confusing. While in the previous study with the AR sandbox the interviews lasted about 15 minutes, the selection process including think aloud comments lasted up to 3 minutes. Like with the game, the evaluation session was also audio-recorded. In order to document participants' choices, photos were taken of the tabletop with the coins put on top of the emoji cards.

Data Analysis

The comments from the think aloud protocol were transcribed into an Excel document together with the ID of the game session. For example, if I were going to report a comment from the first participant of the first game session, I would assign

it the ID "Game 1_A". A second player from the same game would be instead listed as "Game 1_B". Similarly to the previous case study (Section 5.4.1), each comment was categorized according to the emotional state it was describing: happiness, sadness, boredom, confusion, tiredness, anger, educated, and social. For example, if a participant described a confusing situation, that comment would be categorized under "confusion". If a participant talked about learning or discovering something new, then that comment would be categorized as "educated". Moreover, any comment referring to playing alone or with friends would be included in the sub-category "social". There was also an additional category for "other" emotional states. In the same document I also indicated which emoji were selected so that they could be easily compared with the comments. I could infer which emoji were selected from the photos taken. These photos showed which emoji cards were selected, so which emoji cards had coins on top and how many.

5.4.2.2 Participants

The study had 15 participants in total. Four game sessions were carried out at Dyrham Park involving different kinds of visitors, including families with children, couples and adults. 1 game was played by 2 visitors, 1 game by 5 visitors and the remaining 2 games were played by 4 visitors each.

5.4.2.3 Findings

The evaluation phase was very brief. While the previous study (5.4.1) had about 15 minutes of interview for each participant, in this study each group of participants – ranging from 2 to 5 players – had up to 3 minutes to select the emoji that better illustrated their experience with TADT. While this method resulted more rapid than the previous one, this also means that comments were less rich of details. In particular, the think aloud method did not seem to work, as participants often did not comment when selecting emoji. For example, participants always selected emoji B, which illustrates happiness (14 out of 14 times), but this was usually not commented. One reason could be that the game was played by families with children and young children can have difficulty verbalizing their thoughts (Boren and Ramey, 2000). Moreover, emoji are part of our every day life. Selecting them is almost natural and think aloud protocols may be unsuitable for simple tasks that can be described as automatic or near-automatic (Boren and Ramey, 2000).

Players considered the game educative and a fun way to pass time with other people, as Emoji Q (Social) and S (Educated) were selected by 10 out 14 participants (see Figure 22). However, participants only commented to say they particularly enjoy the Auction phase where they could interact with other players, trying to "steal" cards to the adversaries, which would explain why the card illustrating a social experience was also frequently selected. Moreover, during and after the game people asked questions about specific people or objects depicted in the game cards. Therefore, the game seemed to stimulate curiosity, which is confirmed by the

selection of the cards representing education and discovery (Figure 30).

Emoji N (Boring), A (Angry) and V (Tired) were never selected. Indeed, visitors played the game till the end, never displaying any negative attitude. The only player that looked visibly uncomfortable for a moment was a child who selected the emoji illustrating sadness. The child revealed that she did not expect to tell a story herself and was too shy to talk in front of everybody. She had fun when she was buying cards, up to the point at which it was time for her to tell the story. As she explained, this made her uncomfortable. So she selected the emoji expressing sadness. But since she had fun too, she also selected emoji B, which expresses happiness and excitement.

Figure 22: Graphic showing which Emoji were selected and how many times after playing the game

In conclusion, the activity was playful and quite effective in providing an overview on how the group experienced the game. At the end, it was easy to see how many coins were placed in each card. However, participants usually placed their coins but were not particularly interested in commenting their experience, unless they had a negative experience. In general the system was less effective in understanding individual experiences, unless players actually decided to provide some additional feedback, which was not compulsory. This does not mean that cards cannot access individual experiences but in this case the Emoji-cards were deployed as a group experience to all players together. Thus, this specific method is very effective in social experiences, to access a group, as multiple people can use the tool at the same time and it was intuitive for everybody, without age or cultural barriers.

5.5 Strengths and Limitations of Emoji-based surveys

Both surveys resulted intuitive, as participants understood immediately what they had to do and the process for selection was fast as well. The Emoji-based tools proved to be a playful and intuitive because Emoji are widely used through digital communication and thus are easily recognizable. Although the cartoonish style are

usually developed for children, both findings from this chapter and other studies emphasized how image-based tools can be appealing for adult as well (Benedek and Miner, 2002). Emoji resulted also a rapid instrument to understand feelings and gain data from a wide range of users.

While usually only the most motivated people complete surveys (Foster, 2008), the Emoji-based tool was filled out also by less motivated people, people who did not have an extremely positive or negative experience, providing us with a wider range of responses and views. Indeed, the Emoji-tools are such a fast tool that even visitors in a hurry could still select at least one Emoji. Those are visitors who wouldn't necessarily stay for an interview or a focus group. They probably would not even fill out a questionnaire. But the Emoji allowed us to collect at least some form of data from them.

Thus, Emoji-based tools resulted incredibly flexible as they collected data from different visitors and about a range of different experiences, not just those that are educational, but also those that are exciting, frightening, mysterious, and so on. At the end, both tools provided a lightweight method to understand visitors' affective responses to the museum exhibits. They provided additional data corroborate or refute expectations about the suitability of the exhibit for its intended purpose. For example, the Emoji-based survey highlighted confusion regarding the interface of the AR sandbox.

The two case studies presented also some limitations. First, clarity was an important issue since the beginning. Pictures, in particular images of faces, can be misinterpreted, which is why I investigated whether participants understood each emoji intended concept. Through the two studies a basic set of 9 validated emoji were tested in-the-field. Among these 9 emoji, 8 resulted intuitive. The Emoji illustrating *Friendship* was the only one people asked clarification for. Participants seemed to associate a general positive feeling of happiness and relaxation more than a representation of social interaction. People who selected this Emoji were the ones who enjoyed their experience. That is, Friendship was always selected together with at least an average level of Happiness. Moreover, each of the 10 people who selected *Friendship* also stated they would like to play together with friends, so this Emoji appeared to be associated with a playful experience made with friends.

Lastly, (Vidal et al., 2016) suggests that while text-based messages are used to describe an experience, a situation, emoji are used to associate emotions to a specific situation. Indeed, the survey provided an idea of which emotions were felt, but the interview helped to understand "why" that specific emotion was felt. The questionnaire itself was not enough. As combinations are often the best solutions in museums, I suggest complementing the Emoji-survey with text-based comments, think aloud protocols or interviews. In conclusion, the two studies in-the-field confirm that emoji are an intuitive, rapid, and flexible tool to access a variety of visitors' emotions, while comments are still needed to contextualize these emotions.

5.6 Guidelines to Use Emoji as Evaluation Tools

Emoji have been created as a way to facilitate mobile communication, to set a tone and express emotions (Rodrigues et al., 2017). Through this paper, I offer a set including 20 validated Emoji (see Table 15), each representing a specific emotion/feeling. Although those can and should be deployed according to what is being evaluated, I suggest the following basic set of Emoji that can be applied to a wide range of experiences:

- Emoji O – Confusion. Based on findings, this Emoji can measure usability, ease of interaction and whether the content is clear and easy to understand. A user frustrated by an interface or who did not understand some content would most probably select this Emoji.
- Emoji N – Boredom. This Emoji is more related to the quality of the content on whether the experience is relevant and engaging for the user.
- Emoji V – Fatigue. This Emoji evaluates mostly physical tiredness, thus should be used just when exhibits involving some form of physical activity and we wish to measure it. Emoji V could also be used in environments such as Virtual Reality where we wish to evaluate motion sickness.
- Emoji S – Achievement. This Emoji measures whether visitors learned something new and/or was able to complete a task. Emoji S illustrates a feeling of personal achievement.
- Emoji R – Discovery. This Emoji identifies the pleasure of discovering and understanding something new.
- Emoji A – Anger. This Emoji can relate to a variety of factors that can cause anger. For example, this emoji can infer that something really did not work; that the content of the exhibit upset participants.; or that the service was not satisfactory.
- Emoji Q and Q1 – Friendship. Emoji Q1 can be used to either investigate whether the user had a playful and happy experience together with others. Emoji Q is more indicated to measure whether the content stimulate feelings of friendship and harmony. For example, we can think of a movie depicting peace and solidarity.

The discourse over Happiness and Sadness is slightly complicated. Both the studies in-the field included one happy (Emoji B) and one sad Emoji (Emoji H). This was meant to illustrate the emotional states of happiness and sadness. However, we feel like those Emoji were usually chosen as like or dislike values. None of the participants looked properly sad and the AR Sandbox was not designed to provoke sadness. Thus, it would be interesting to compare the use of Happy and Sad Emoji versus Like and Dislike Emoji. That would be Emoji with thumbs up (Emoji Y) or down (Emoji T). Thus, Like and Dislike could be used for general purpose to highlight whether participants had a pleasant experience or not. While Emoji representing

happiness and sadness should be used with experiences that are supposed to elicit such emotional states:

- Emoji B – Happiness. This Emoji measures whether the experience was pleasant and satisfying.
- Emoji H – Sadness. This Emoji measures whether the experiences was not pleasant and/or elicited sadness.
- Emoji Y – Thumbs Up. This Emoji measures whether a visitor liked the experience.
- Emoji T – Thumbs Down. This Emoji measures whether a visitor did not like the experience.

Now we know what each Emoji can measure and when to use them. The two studies in-the-field also indicate how we can deploy those Emoji to evaluate visitors' affective states:

Category. As expected, a combination of instruments is usually the best solution as it can reach a wider audience and provide different kinds of data. Indeed, many contemporary institutions such as the British Museum (Morris Hargreaves McIntyre, 2013) and the Smithsonian (*Visitor Evaluation Guidelines*, 2015) are using a mix of qualitative and quantitative methods to support their users evaluation. Thus, when it is possible I suggest supporting this data with other self-reporting methods such as interviews. Interviews provided a good understanding of the context in which people felt an emotional state. However, think aloud protocols may be unsuitable for simple tasks that can be described as automatic or near-automatic, such as selecting cards (Section 5.4.2). Think aloud protocol is also not suitable for young children as they have difficulty verbalizing their thoughts. Text-based comments or drawings could be a better fit. For example, during TADT (Section 5.4.2) a girl was not able to tell a tale but she was happy to draw her story.

Layout. Emotions are subjective and dynamic. Different emotions can coexist at the same time (Boehner et al., 2007). Thus, I tend to present the emoji together in a random order. I also present the emoji in line rather than in a wheel, opposed to each other, in order to not suggest a valence. Indeed, participants selected more than one Emoji during the two studies in-the-field, so the approach seems to work well.

Intensity. During the study with the sandbox (Section 5.4), a 3 points scale was used, allowing participants to pick low, medium or high intensity of a specific emotion. This was not replicated in the second study with TADT (Section 5.4) because the intensity levels created some confusion during the first test to validate an Emoji-based method. However emotions are incredibly dynamic and can present themselves at different level of intensity (van Goozen et al., 1994). Thus, further studies should examine the possibly of using a more intuitive point-scale. Social networks such as Facebook are already offering the possibility to their users to select the "size" of the Emoji. For example, if users really like something, they just need to hold the Emoji to select a bigger size. I believe this could be replicated in museums,

where visitors could simply use different Emoji or different intensities to express their experience with specific display or full exhibitions. But the survey should be kept short in order to not disrupt the museum visit. From the study with the interactive sandbox (see section 5.4), I infer that 3 levels of intensity should be enough.

5.6 Summary

In this chapter, I described how museums are currently evaluating visitors' experiences. Emotions are a key aspect of visitors' experience, influencing perception of authenticity and entertainment and ultimately whether we are satisfied or not. Thus, I focused on how emotions and affective states are measured in different fields. Traditional methods to evaluate visitors' experience include direct observation, survey, and interview. However, affective stated are very complicate to access just by looking or talking with people. Moreover, questionnaires are often not appealing, so visitors do not fill them out or if they do so, the answers are not always candid. Thus, I identified a lack of tools to access visitors' feelings in a way that is effective, rapid and does not disrupt the visit.

I identified emoji as a mean to measure affective states because Emoji are a common language in the digital age and are used daily to communicate emotions, for example through social media. In particular, face-based Emoji can express different emotional states through facial expressions. There are already examples of companies implementing basic Emoji-based surveys for their public. For example, MAC Cosmetics produced a series of postcards with 3 basic Emoji: happy, neutral and unhappy. Similar emoji systems are often seen in kiosks at airports as a method to empower customers and measure their level of satisfaction (Dickinson, 2018).

I wanted to measure a wider range of emotional states. Thus, I developed an intuitive and rapid system to evaluate people's satisfaction besides the simple state of happiness and unhappiness. I designed and validated the meaning of a set of 20 emoji (Table 15). The validation process included two word association tasks and a frequency analysis (Section 5.3). I then confirmed findings from the validation tests through two studies in-the-field: a paper-based survey to measure users' emotional experiences with an augmented reality sandbox (Section 5.4.1) and a cards-based system to evaluate Tell-A-Dyrham-Tale (Section 5.4.2).

Finally, I have provided a set of guidelines to use emoji (Section 5.5), focusing on a basic set of emoji: emoji representing *confusion* to measure whether the experience is clear and usable; emoji representing *boredom* relates to the quality of the content provided; emoji representing *fatigue* measures physical fatigue; emoji illustrating *achievement* can measure learning outcome or other kinds of achievements; emoji illustrating *discovery* relate to the pleasure of discovery something that was unknown before; and emoji representing *anger* can be caused by usability issues, unsatisfactory service and a variety of other options

The discourse over *happiness* and *sadness* is slightly more complicated. I

validated an emoji for happiness and one for sadness to measure joy and sadness. These emoji can also be used to indicate whether someone liked or disliked the museum experiences. However, the emoji representing Thumbs Up and Thumbs Down could be more suited to indicate whether the experience was generally satisfying or not. Finally, based on the two studies in-the-field, I suggest three main points: (1) deploy emoji-based surveys together with other methods, such as interviews; (2) display the emoji in a random order and not opposite to each other in order to not suggest valence; and (3) consider whether intensity levels are indeed needed and if so, three levels should suffice.

Chapter 6

Conclusion

This chapter summarises the thesis, providing a brief overview of each chapter and the main contributions (Section 6.1). Then, I reflect upon research outcomes, focusing on each research question (Section 6.2). The Chapter concludes addressing the limitations of this research and suggesting directions for future work to overcome those limitations (Section 6.3).

6.1 Thesis Summary

In **Chapter 1**, I described how digital technologies are influencing society, changing the way we live and communicate with each other, and pressuring museums intro re-thinking their offer. In particular, games are increasingly relevant in the digital age and they are currently among the top entertainment options for people of different ages and socio-cultural background.

As society changes, museums need to re-think how they interact with the public and share knowledge in order to stay relevant and drive visits. Museums should provide visitors the same emotional and psychological experiences as games, and enhance user's overall value creation using game affordances (e.g. achievements and challenges), stimulating participation, creativity, curiosity and perseverance. However, museums have been using games mostly as educational tool and not as a method to collect data. In this thesis I explore how games can be used for other purposes, namely to empower both museum professionals and the public, to facilitate the introduction of gameful experiences in museum, and as a research method.

In **Chapter 2** I explored how changes in society are affecting museums and visitors' satisfaction. In particular, this chapter reflects upon the concepts of authenticity and entertainment in contemporary museums. In the digital age, museums need to design experiences that are not only *objective* authentic but that are also perceived as meaningful by the visitors. Visitors are asking for experiences that are not only educative but also entertaining and relevant to them. Visitors should be able to relate, connect and create new meaning. If what the museum offer is not just relevant to the museum itself but also to their visitors, than people are more likely to be interested, to pay attention, enjoy and remember the experience. In the digital museums visitors do not just wish to be engaged, educated, but also entertained. However, both authenticity and entertainment are very subjective and

can limit each other.

Museums are often worried that by focusing too much on entertainment, they would loose their authority. While a traditional object-centered exhibition based on curators' choices and object authenticity leads to a very passive experience. Participation is suggested as a solution to involve the public in the design process. Participatory practices such as collaborative workshops or games allow visitors to contribute and create meaning. The same practices allow museums to better understand their visitors and design exhibitions that are more relevant to them.

While museums have the ability to share knowledge in a way that is not only educative but also enjoyable (Falk and Dierking, 2000), they still struggle with the introduction of both participatory practices and digital technologies. **Chapter 3** builds upon the idea that museums need to re-think their offer, including digital technologies and involving visitors in the design process, but they often struggle. Museums still hesitate to use digital technologies and participatory practices for a variety of reasons. First, most museums still prefer the traditional object and curator-centered approach. Then, museum professionals often lack expertise and experience to develop and maintain digital technologies.

One of the main aims of this thesis is to overcome barriers museums have towards digital interactivity and participatory practices using game-based activities. I have done so through two studies: (1) a game-play session with curators of the National Trust UK, and (2) a game-making workshop with museum professionals from different institutions. The first case encouraged dialogue and creativity, supporting the development of a new interactive narrative. Similarly, the second study strengthened skills typical of gamers such as creativity, determination, capacity of overcoming obstacles and collaboration. By making games, museum professionals also gained experiences and confidence with digital tools. For example, museum professionals confirmed in the post-survey that they planned to use tools learned during the event in their institution.

In **Chapter 4** I proposed a Research through Games method (RtG) *that employs game creation and game play to inform future user experiences that are both meaningful and entertaining*. Thus, I used gameful experiences as research tool to collect information from participants and solve issues relevant to the museum context. For example, museums now own an increasing number of digital artefacts. However, these collections are often archived and not shared with the public as museums still struggle with the deployment of digital technologies, including games and other interactive experiences. Thus, I run a workshop with the general public, asking them to make games around digital artefacts. I analyzed the design process and how the games were perceived during a public showcase in order to understand how digital artefacts can be interpreted and perceived.

Another issue is that the rapid development of digital technologies is pressuring museums to re-design their narrative in order to drive visits and stay relevant. This means that is increasingly important for museums to communicate with the public and learn what are their expectations and their interests (see Chapter

2). By involving the public in playing a storytelling game, I was able to collect information from visitors, gaining a better understanding of which bits of information are more relevant to them and could be shared through new visitors' experiences.

At this point, I had a clear idea of what authenticity and entertainment are and how they fit into visitors' satisfaction. I also investigated how to collect knowledge from visitors and facilitate museum professionals with the design of interactive experiences. Through Chapter 3 and 4 I provided guidelines on how gameful experiences can facilitate the design of visitors' experiences that are both authentic and entertaining. Museums can use those guidelines to organize game-based activities and collect data.

In **Chapter 5**, I have asked how visitors' satisfaction can be measured in the digital era. It is important to communicate with visitors not only before and during the design process but also after, to ensure the experience is indeed perceived as authentic and entertaining. This task is not easy because visitors' experiences are incredibly subjective and complex to measure. Therefore, I investigated a new method to evaluate visitors' experiences in the digital museum. The evaluation method is image-based survey based on emoji. I decided to use emoji because they are a common language in the digital age and are used daily to communicate, for example through social media.

I designed a set of emoji and I validated the meaning of 20 of them. This wide range of emoji could allow me to measure multiple affective states, including not only happiness/unhappiness but also for example boredom and achievement. Finally, two studies in-the-field were carried out in order to determine whether Emoji-based surveys can indeed access visitors' personal feelings. The outcomes were generally positive, and the method resulted also rapid and unobtrusive.

6.2 Thesis Outcomes

Games have an increasing reach in society and are seeing unprecedented interest in the academic world. For example, game-based activities have been used to inform the design of new products and user experiences. However, their use for research purposes in non-game contexts still remains little investigated. In particular, museums are using games mostly as an educational tool. In this thesis, I used games also to empower museum professionals and the public, to collect information from participants, produce knowledge and solve issues relevant to the museum context. In this thesis, I investigate how game play and game making can facilitate the design of new visitors' experiences. My main research question is:

Can gamefulness promote authentic and entertaining experiences in museums?

Gamefulness was never defined in relationship to the museum context before. The introduction of this thesis illustrates that a museum is gameful when it

provides visitors the same emotional and psychological experiences as games, using game-based activities and affordances (e.g. achievements, challenges and stories/themes) to stimulate participation, creativity, curiosity and perseverance.

In this thesis I have used game play and game design to successfully engage with both museum professionals and the public. First, gameful activities have helped museum professionals with the design of new interactive experiences, promoting the introduction of entertaining experiences in the museum context. Secondly, game-based experiences involved the public directly in the design process, providing a better understanding of their interests and how they perceive digital assets in museums. This knowledge promoted the design of experiences that are not only entertaining but also authentic for the public.

6.2.1 What are authentic and entertaining experiences in the digital museum?

Both authenticity and entertainment evolved through time and were particularly affected by the rapid development of digital technologies. Their perception is also very subjective and a variety of definitions have been proposed in fields such as museum studies, marketing, health, games, media and entertainment studies. Moreover, museums usually refer to engagement not entertainment. Thus, the definition of entertainment and authenticity in the museum context were not so straightforward, but they were necessary to answer my main question. In Chapter 2, I identify two main dimensions of **authenticity**:

(1) Objective authenticity where we identify as authentic a museum object that is original, unique or existing in nature. Objective authenticity can be tangible (e.g. buildings and furniture) but also intangible (e.g. social practices and rituals). This means that human behaviour and habits can also be considered objectively authentic if they are historically accurate.

(2) Subjective, which depends on people's perception of how authentic an experience is for them. As museums are switching from an object-based to a visitors-centered perspective, subjective authenticity is becoming increasingly important. Moreover, museums own a growing collection of digital assets. Digital replicas, together with places and living organisms can be all considered authentic depending on how they are presented and perceived, and whether the narrative is relevant and meaningful to the public.

I also I define **Entertainment** as a pleasant experience that happens when one or more external stimulus (e.g. a theatre play, a movie) holds someone's attention. Differently from engagement, entertainment does not need to be educational and focuses instead on a more 'recreational' experience. Theatre performances have been already successfully used as form of entertainment in museums, while games holds an incredible potential to offer narratives that are more immersive and engaging.

Then I explored how authenticity and entertainment relate to visitors'

satisfaction. Thus, this thesis argued that visitors have **satisfying experiences** as a result of the total museum experience, so whether visitors felt achievement and/or acquired new knowledge; whether the narrative was relevant, enjoyable and clearly communicated to the public; and whether visitors felt involved.

Finally, I suggest **participatory practices** as a successful method to develop museum experiences that are both authentic and entertaining (Antoniou et al., 2013; Druin and Fast, 2002; Simon, 2010; Tinkler, M., 1998). If people participate in the design process, then museums can understand what is relevant to them prior to their visit, reduce the risk of failure and meet visitors' expectations (Chen and Chen, 2010).

Participation provides a platform for dialogue (Sanders, 2003), so that visitors can *contribute, discuss, create their own meaning and connect* (Simon, 2010). When visitors are involved directly in the making of the museum experience, they feel more involved (both individually and socially) and consolidate their relationship with the museum. Can game-base activities work as a form of participatory practice and empower both museum professionals and visitors?

6.2.2 Can gameful activities empower museum professionals and support the design of interactive experiences?

Digital technologies are rapidly evolving and are now part of our everyday lives. On one side, technology is pressuring museums to re-design their exhibitions. On the other side, museum professionals are often the main barriers to the introduction of digital technologies. Museum professionals' scepticism is mainly due to a lack of technical skills and a long-standing experience with the design of passive object-centered exhibitions.

Since museum professionals are often not directly involved in the design process of digital experiences, they rarely have the opportunity to gain new experience. I run two workshops to game-based workshops in order to empower museum professionals, provide them with direct experience, and facilitate the introduction of digital experiences, in particular games.

In the first case, museum professionals from the National Trust UK played **1001-Dyrham-Tales**, a storytelling game. Chapter 2 confirmed that a good narrative is essential for museums and is strongly related to the concept of authenticity and entertainment. Although telling stories is what museums do (Johnsson, 2006), this is not always an easy task. 1001-Dyrham-Tales facilitated curators with the design of new interactive narrative.

For example, the game highlighted the importance of empathy and sympathy. Details of the travel could bring characters' humanity 'alive', help us understand their experience and feelings. While drawing parallel with our own life today (e.g. caring parents worrying about their children travel) could create a deeper emotional level with historical characters. The game also sparkle some curiosity about women and their role in society. Finally, players also gained a better

understanding of how the narrative should be delivered, identifying possible issues before the final design of the system.

In the second case, museum professionals from different institutions attended **GameTale**, a game jam during which they made a series of games. By making games, museum professionals gained experience as game players and developers. For example, participants learned how and when to use new digital tools for game development. Participants demonstrated interest in deploying such technologies in their museums, which means the event supported the design of new interactive experiences.

6.2.3 Can game-based activities facilitate the understanding of what is meaningful and entertaining for visitors?

If gameful activities empower museum professionals and support the design of interactive experiences, can they also provide a better understanding of what is relevant and entertaining for the public? Via game play and game design, I have engaged the public in the design process, collecting information from the public to produce knowledge and solve problems relevant to the museum context.

Through **TADT** (Section 4.4) I gained knowledge to answer two main questions: (1) Which bits of narrative are more appealing to visitors? (2) How do visitors perceive different narrative genres? Visitors were interested in discovering the origin of museum objects and learning about people who lived in the historical property. In particular, players were curious about the women, what they did and how they lived. Moreover, players apparently considered historical information not sufficiently engaging and added fictional elements (e.g. mystery and fantasy) to make their stories more appealing.

Through **GT** (Section 4.5) I gained knowledge to answer two main questions: (1) How do participants perceive and interpret digital artefacts? (2) How do participants perceive digital artefacts within games? Participants demonstrated an increasing interest in the artefacts and their history while they were designing the games. At the end, 9 games were developed. However, only one game was strongly based on the historical background of the object while another was educative and tried to deliver information regarding the artefacts. The other games used the artefacts mostly as a game component. As a result, visitors found the games generally engaging but did not perceived the objects in the games as artefacts.

Based on the experience from the two studies, I also provided an initial set of guidelines to set up RtG. In particular, I identified the following four **key features** of RtG. First, the experience should be entertaining itself for the participants. We are not just collecting information, we are offering the 'game experience'. Secondly, data collection should not disrupt visitors' experience, should be reliable, well-documented and consistent. I collected data using a combination of short semi-structured interviews, direct observation, pre- and post- surveys, directed storytelling techniques, video and audio recordings. I also designed checklists to

make interviews and observation more consistent. Thirdly, it is important to balance freedom and constraints, so that gamers can be creative while focusing their efforts in the direction we wish to investigate. This means researchers using RtG should have a clear idea of the answers they are trying to solve. Then, game rules and theme of the game jam should be well defined and clearly communicate to the participants accordingly to the research questions previously set. Lastly, results should be shared.

6.2.4 How do we evaluate visitors' subjective experiences in the gameful museum?

Emotions are a key aspect of visitors' experience, influencing our perception of authenticity and entertainment and ultimately whether we are satisfied or not. Therefore, I investigated on how emotions and affective states are measured in different fields. Traditional methods to evaluate visitors' experience include direct observation, survey, and interview. However, affective stated are very complicate to access just by looking or talking with people. Moreover, questionnaires are often not appealing, so visitors do not fill them out or if they do so, the answers are not always candid. Thus, I identified a lack of tools to access visitors' feelings in a way that is effective, rapid and does not disrupt the visit.

I identified emoji as a mean to measure affective states because emoji are a common language in the digital age and are used daily to communicate our emotions, for example through social media. In particular, face-based emoji can express different emotional states through facial expressions. Therefore, I proposed an Emoji-based method to evaluate visitors' subjective experiences in museums (Chapter 5). As a result of this investigation, I provided designed and validated the meaning of 20 emoji that can be used to access visitors' affective states (Table 15).

Emoji-based tools were also tested in-the-field. These tools included a basic set of emoji. In Chapter 2, I argued that visitors have satisfying experiences as a result of the total museum experience, so whether visitors felt achieved and/or acquired new knowledge; whether the narrative was relevant, enjoyable and clearly communicated to the public; and whether visitors felt involved. Therefore, I selected emoji that could illustrate sense of achievement, discovery, enjoyment, social involvement, confusion (i.e. experience was not clear), boredom (i.e. experience was not engaging/relevant), anger (i.e. experience was not pleasant and unsatisfactory), and tiring (i.e. experience was physically tiring).

These emoji were deployed in-the-field in two occasions. First, I designed a paper-based survey to successfully measure visitors' experiences with an augmented reality sandbox (section 5.4.1). Lastly, I have printed emoji as a set of cards and used them as a prompt to stimulate visitors' emotional feedback and evaluate Tell-A-Dyrham-Tale (section 5.4.2). emoji successfully provided information about visitors' emotional states and a better understanding of their subjective experience. Moreover, the tool was rapid and intuitive.

6.3 Final Considerations

In this section I identify two main **limitations** of this dissertation, both related to generalisation. I reflect upon them and suggest **future studies** to overcome such limitations.

First, sometimes the studies presented in this thesis involved small samples. For example, in our play session with museum professionals I involved 3 people (section 3.3). However, I run primarily empirical studies and collected qualitative data. Contrarily to quantitative studies, there is no ideal sample size in qualitative studies (Mason, 2010; Robinson, 2014). In the past, researchers have considered fifteen as the smallest acceptable sample in qualitative research (Mason, 2010). However this number is mostly considered as guidance without empirical evidence to support it (Mason, 2010). (Mason, 2010) analysed a variety of qualitative studies and found that they used from 95 to 1 participant/s. (Boddy, 2016) confirmed that sample sizes involving even just an individual case can be informative, reliable and generalizable. Moreover, sample size is by no means the only factor influencing generalizability (Robinson, 2014). The number of data collection methods also matters (Mason, 2010). By using multiple methods (e.g. observations, interviews, and surveys) the studies provided a reasonable amount of information with less participants (Mason, 2010). Nonetheless, I am planning a series of new studies in order to gain additional data from both museum professionals and the public. These include gameful activities for the National Trust and the conference ECSITE 2018, as well as a second and third edition of GameTale.

Secondly, our studies were investigated exclusively in the museum context. This could raise arguments about the generalizability of this research. However, both gameful activities and Emoji-based tools can be easily applied to other contexts. Fields such as marketing and health are already considering game-like applications as a method to collect data from users (Adamou, 2011; DeVault, 2017; Morgan, 2016). Few airports and business around the world are already deploying a small set of emoji to evaluate basic consumers' satisfaction (Bacon et al., 2017), for example whether a consumer is happy or not[33]. Moreover, by actually focusing on museums I were able to contribute to a better understanding of entertainment and authenticity in the context of contemporary museums. This research is also one of the first to investigate the role of games in museums not only as educational tools but also as co-design and research method. Finally, the studies were carried out both in the lab and in the field (i.e. in museums), involving different stakeholders. I did not engaged only with visitors but also with museum professionals, students, game developers and entertainment companies.

[33] *https://www.happy-or-not.com/en/*

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Appendix A: Tell-A-Dyrham-Tale Cards

2

(1650-1691) Heiress of the Dyrham estate. She married Blathwayt in 1686 when she was 36-year-old. She died 5 years later

MARY WYNTER

1

(1649 – 1717) He was Secretary of War to William III from 1683 to 1704. His salary was considerable and supplemented by 'fees' for services such as helping expediting business with London

WILLIAM BLATHWAYT

4

The Victoria & Albert Museum is the world's largest museum of decorative arts and design and was founded in London in 1852

V&A MUSEUM

3

During the 1710 inventory, the pair of bookcases were recorded as "two Glass Presses"

GLASS PRESSES

1659

POLITER WAY OF LIVING

SAMUEL PEPYS

ACANTHUS AND ROSES

6

Charles II's return to England encouraged a 'Politer Way of Living' with the collection and display of cultural artefacts, including books and glazing of bookcases

POLITER WAY OF LIVING

5

The bookcase is one of a pair made for William Blathwayt in ca. 1695/1705, for the North end of Dyrham Manor

1659

8

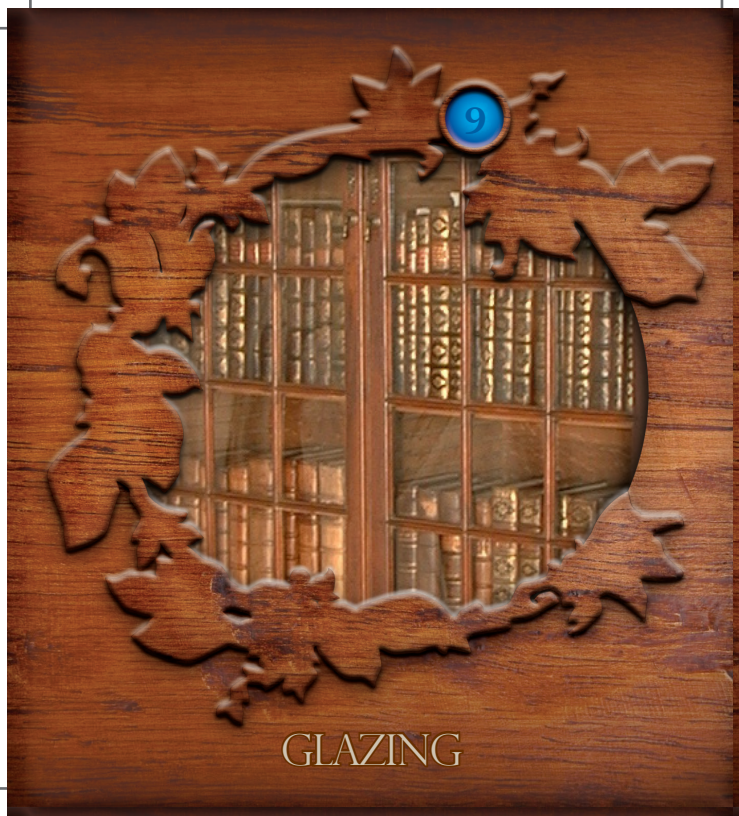
Both upper and lower cornices are carved with acanthus foliage. The lower corner is also carved with petals and husks above a running pattern of roses

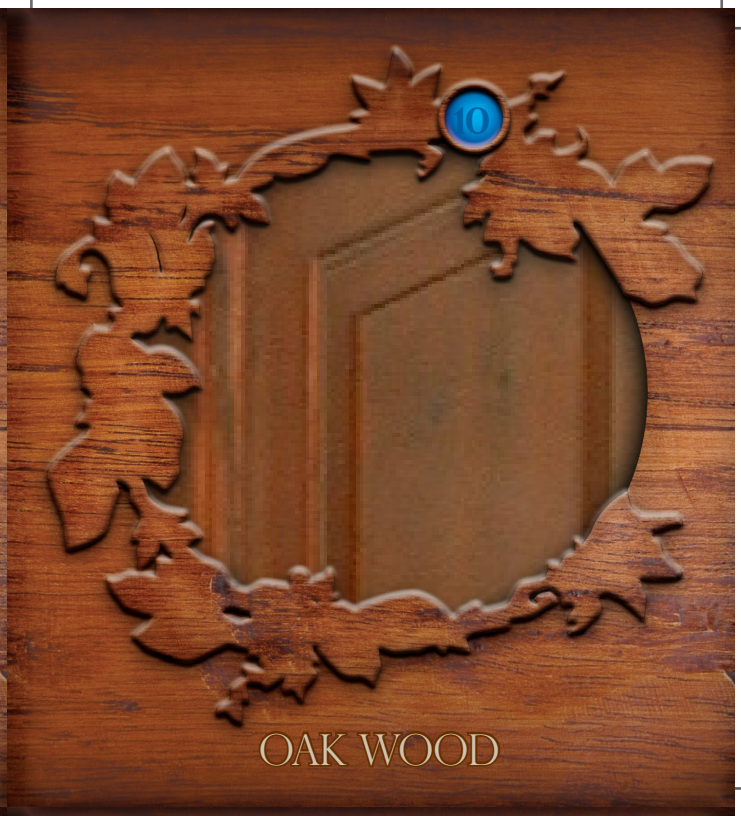
ACANTHUS AND ROSES

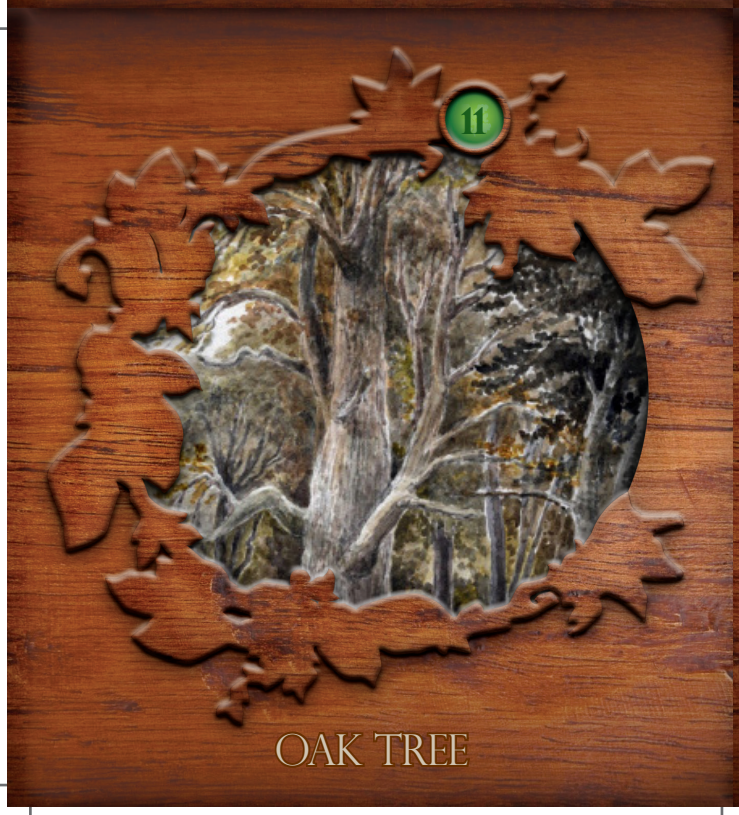
7

(1633 – 1703) He was a Member of Parliament and Secretary of State to the Admiralty. He is most famous for the diary he kept for about a decade

SAMUEL PEPYS


9
GLAZING


10
OAK WOOD


11
OAK TREE


12
TANNIN

10

The boockase is made of oak. Oak wood is really resistent and has been also used for interior panelling of prestigious buildings like the House of Commons in London

OAK WOOD

9

The glazing of the bookcase is original. It protected the books but also gave them greater value. Glazing bars and doors followed the fashionable design of contemporary sash windows

GLAZING

12

Oak wood is resistant to insect and fungal attack thanks to its tannin content. Tannin is a reddish vegetable acid, used to make ink and leather. It also gives an astringent taste in wine

TANNIN

11

An oak is a tree or shrub of the beech family. It is native to the Northern Hemisphere, and extends to the Americas, Asia, Europe, and North Africa

OAK TREE

13

PEPYS' LIBRARY

14

THOMAS SYMPSON

15

XVII INTERIOR

16

DYRHAM PARK

14

A master joiner at the Dockyards under Pepys control. He constructed Pepys' library and may have designed Blathwayt's

THOMAS SYMPSON

13

Dyrham's bookcases are similar to those designed in 1666 for Samuel Pepys. Pepys' bookcases were among the first glazed cases and would have been much admired

PEPYS' LIBRARY

16

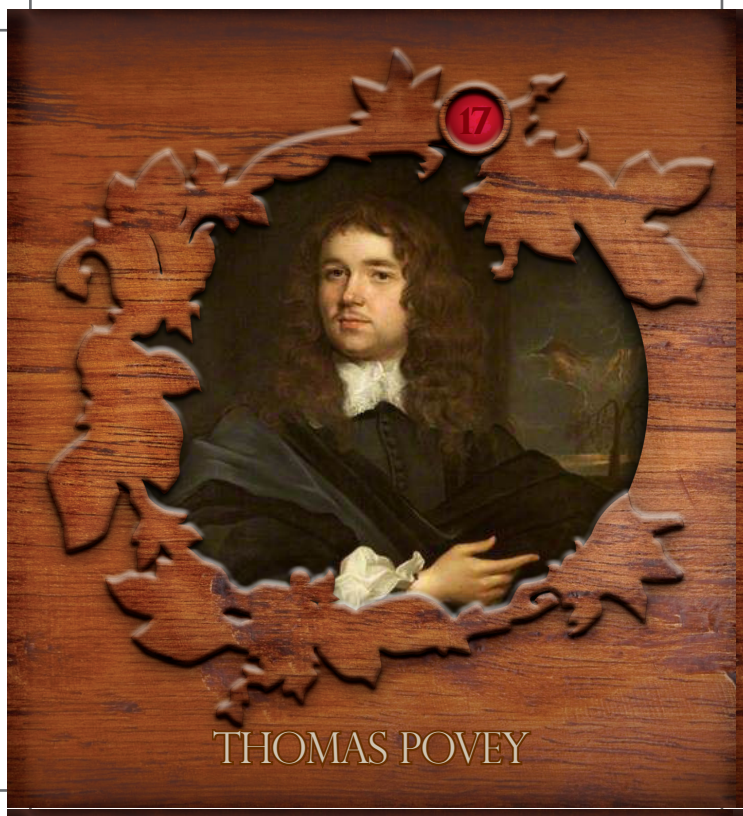
Blathwayt was never ennobled, so when he inherited Dyrham in the 17th-century he built the Tudor mansion and the garden to express his status

DYRHAM PARK

15

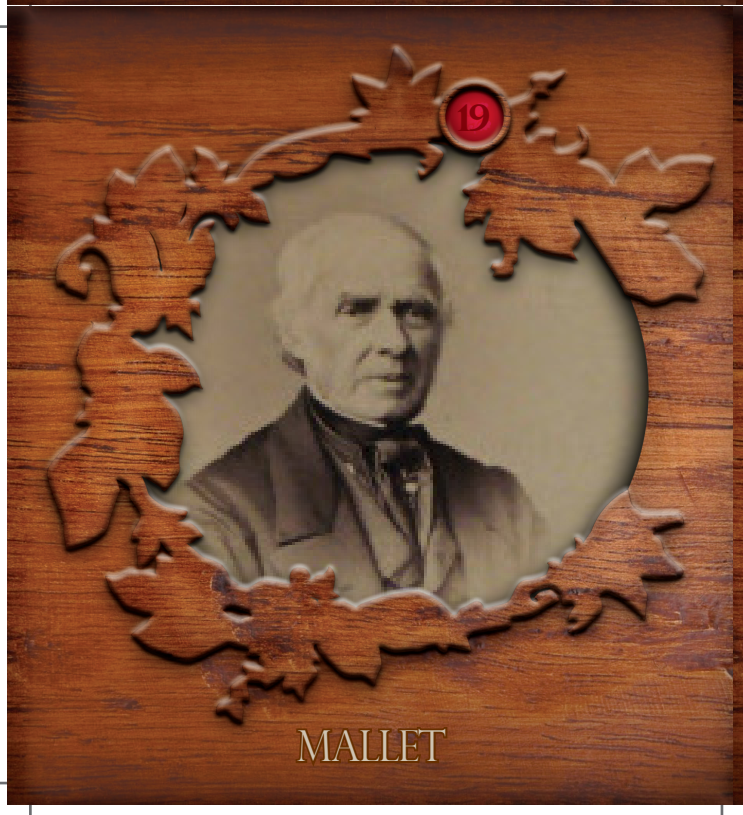
The interiors of this period are remarkable for their richness, based on the forms and style of Ancient Rome. Acanthus leaves and cupids appeared everywhere

XVII INTERIOR



THOMAS POVEY

SHELVES



MALLET

“A COPY...”

18

Each of the upper cupboard units contains three adjustable shelves. The bottom section is wider and deeper to house folio volumes

SHELVES

17

(1613/14-1705) He was Blathwayt's uncle and a merchant-politician. Because of his friendship with Samuel Pepys, Blathwayt may have seen Pepys' library

THOMAS POVEY

20

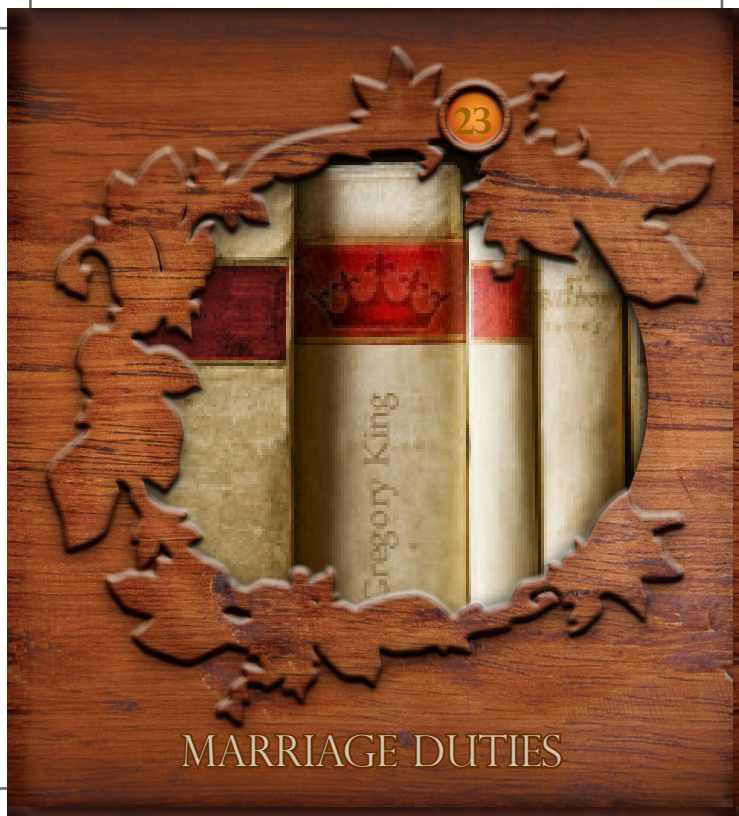
The original bookcase was sold to to the Victoria & Albert Museum. According to notes, in 1967 there were "2 bookcases at Dyrham", one being "a copy ..."

"A COPY ..."

19

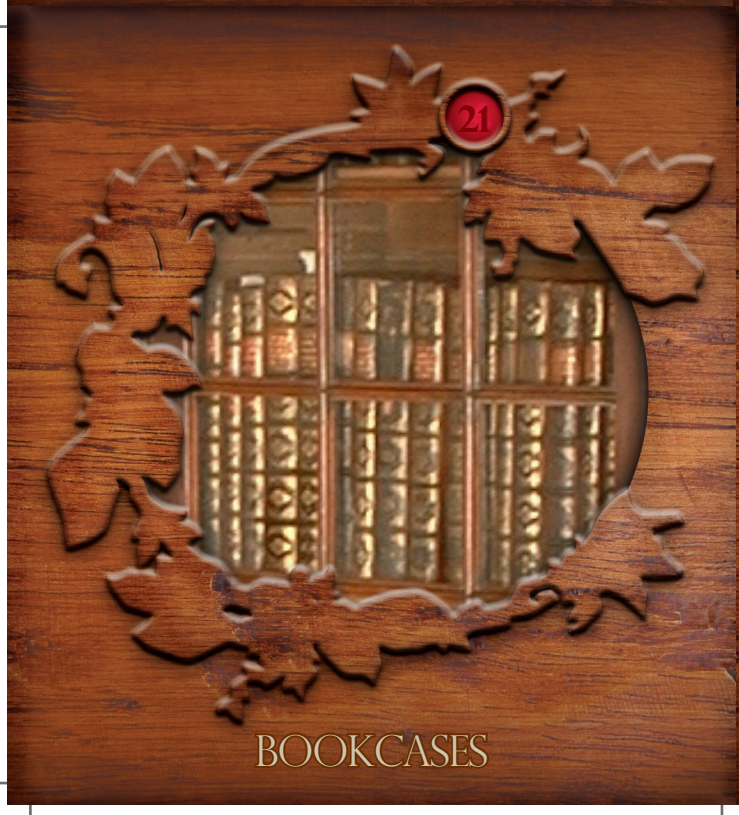
The bookcase at Dyrham is a copy made by Malletts of Bath in 1927. Mallett is one of the oldest antique dealers in the world and was founded in 1865 by John Mallet

MALLET

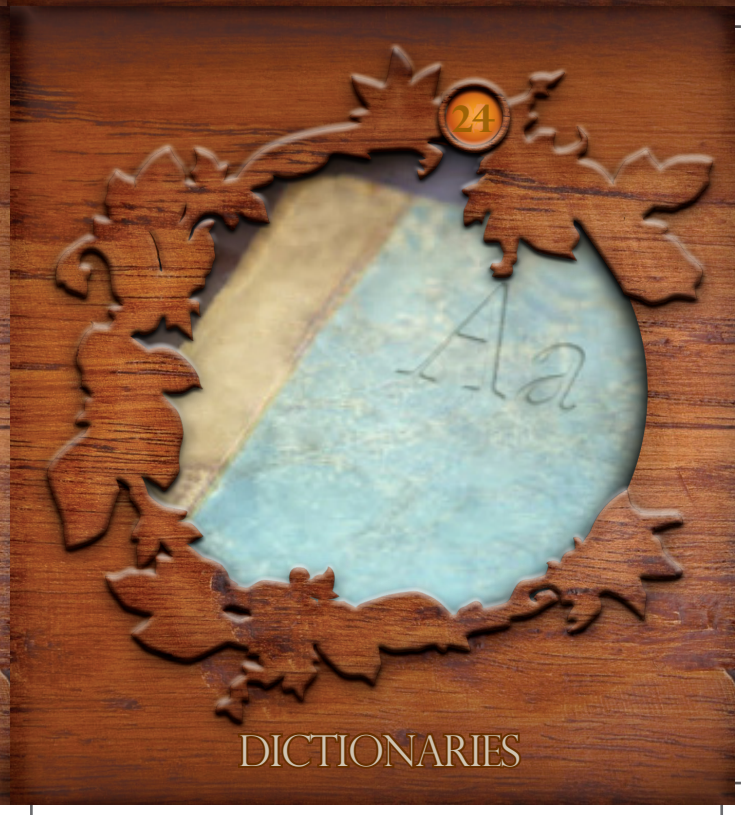


MARRIAGE DUTIES

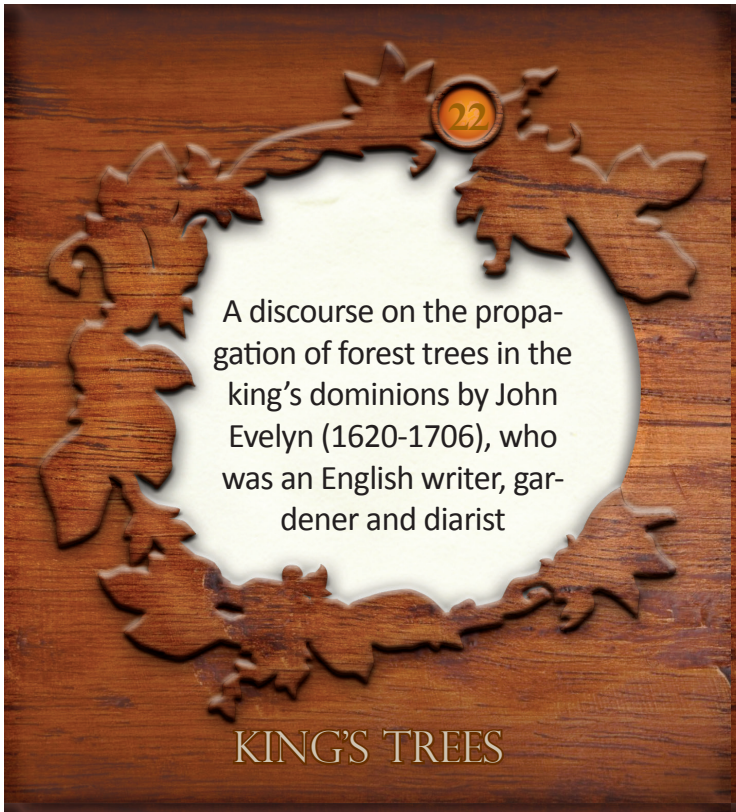
KING'S TREES

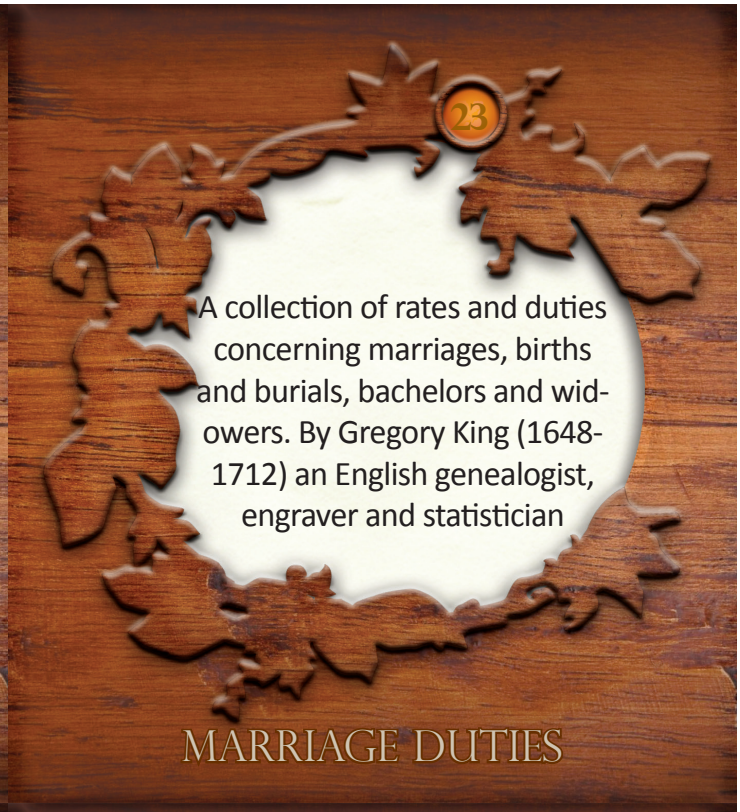


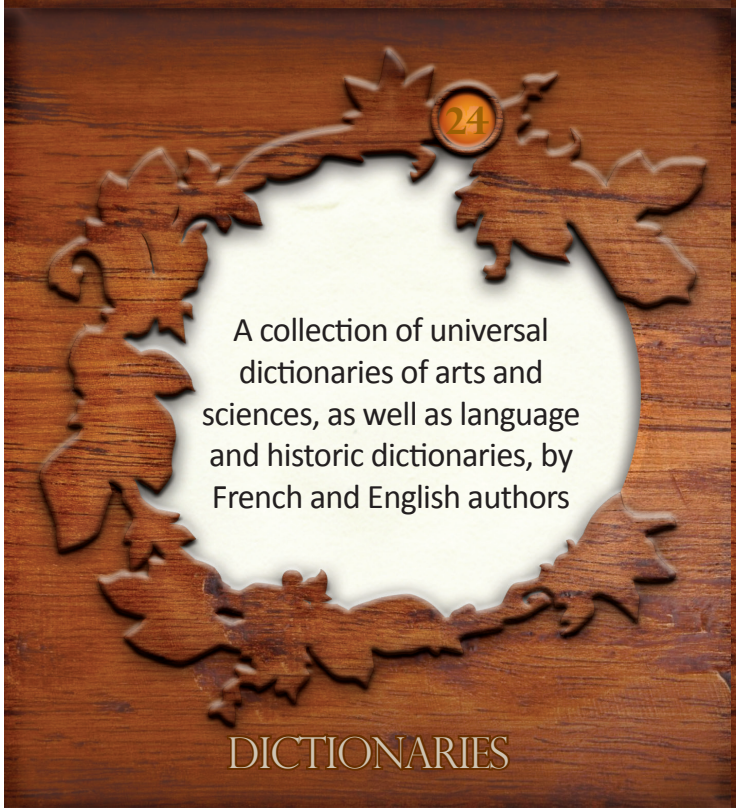
BOOKCASES

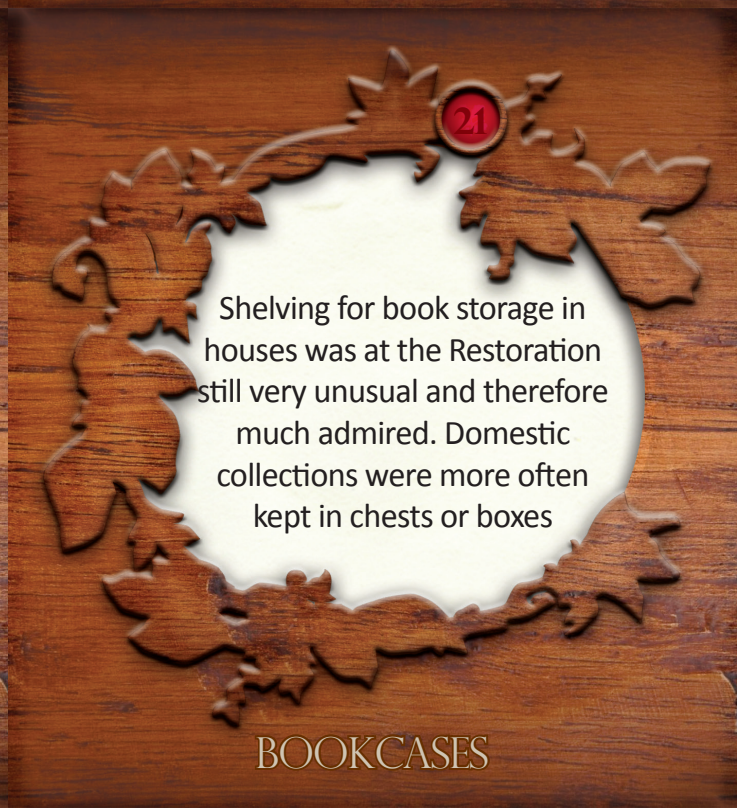


DICTIONARIES


22
A discourse on the propagation of forest trees in the king's dominions by John Evelyn (1620-1706), who was an English writer, gardener and diarist
KING'S TREES


23
A collection of rates and duties concerning marriages, births and burials, bachelors and widowers. By Gregory King (1648-1712) an English genealogist, engraver and statistician
MARRIAGE DUTIES


24
A collection of universal dictionaries of arts and sciences, as well as language and historic dictionaries, by French and English authors
DICTIONARIES

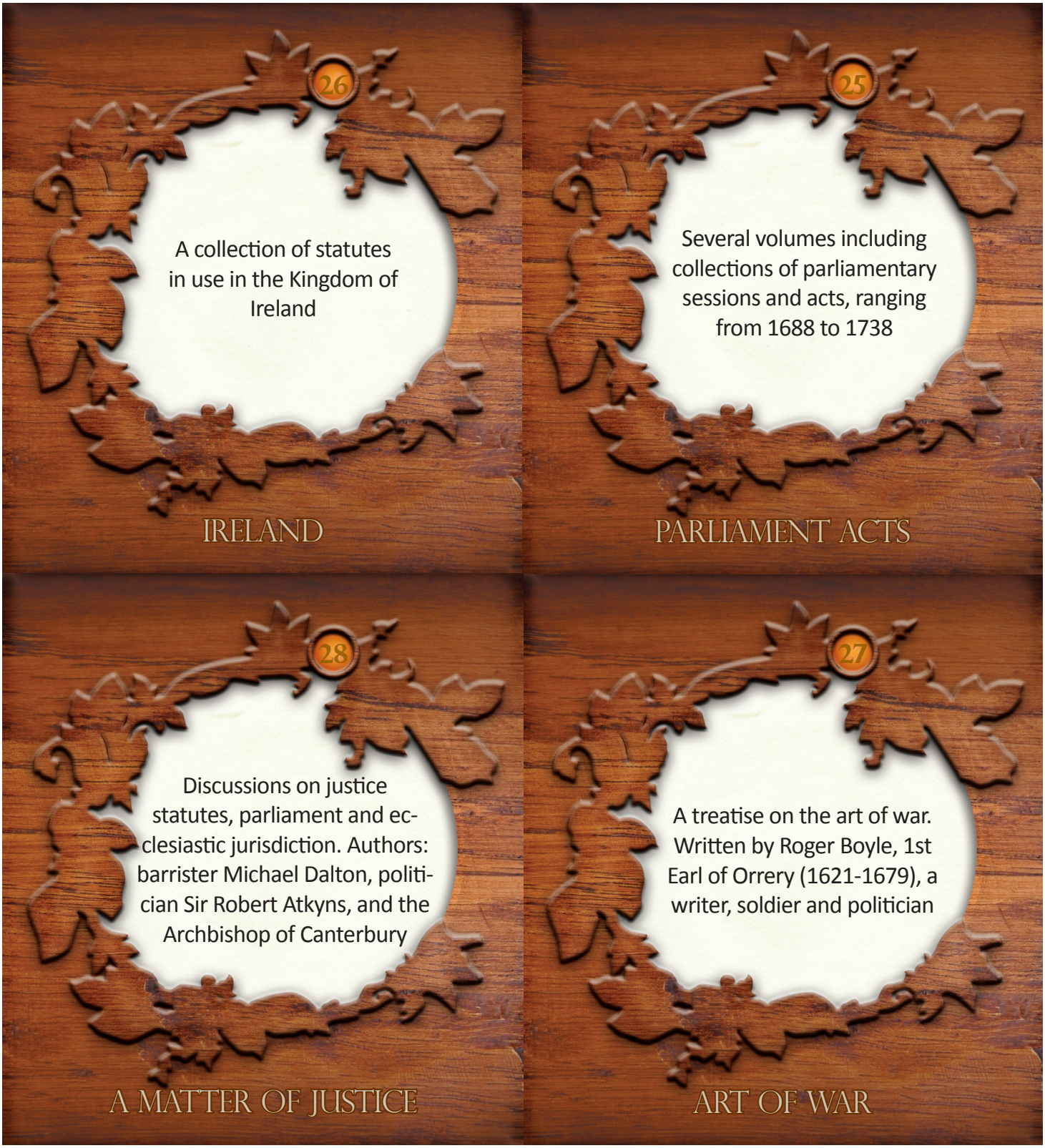

21
Shelving for book storage in houses was at the Restoration still very unusual and therefore much admired. Domestic collections were more often kept in chests or boxes
BOOKCASES


25
Parliament
PARLIAMENT ACTS


26
IRELAND

27
ART OF WAR

28
A MATTER OF JUSTICE


26
A collection of statutes in use in the Kingdom of Ireland
IRELAND
25
Several volumes including collections of parliamentary sessions and acts, ranging from 1688 to 1738
PARLIAMENT ACTS
28
Discussions on justice statutes, parliament and ecclesiastic jurisdiction. Authors: barrister Michael Dalton, politician Sir Robert Atkyns, and the Archbishop of Canterbury
A MATTER OF JUSTICE
27
A treatise on the art of war. Written by Roger Boyle, 1st Earl of Orrery (1621-1679), a writer, soldier and politician
ART OF WAR

RELIGION

PRINCE D'ORANGE

INK

ARISTOTLE'S PHYSICS

30

History and life of Frederic Henry de Nassau Prince d'Orange. Written by Isaak Commelin (1598 - 1676) a Dutch historian

PRINCE D'ORANGE

29

Sermons, New and Old Testament are discussed and explained by religious commentators such as Samuel Otes, Anthony Farindon, John Trapp, and John Richardson

RELIGION

32

Old manuscript containing a corpus of Aristotle's physics. Written by Franciscus Vicomercatus (1474 - 1598), an Italian philosopher and physicist

ARISTOTLE'S PHYSICS

31

Manuscript about the composition of Ink, probably from early eighteenth century

INK

Appendix B: Tell-A-Dyrham-Tale Rules

Introduction

The object of Dyrham Tale is for the players to tell a good story by using a set of cards. Each card displays a piece of information related to the Dyrham bookcase. At the beginning of the game, the players have coins but no cards. The game master will sell the cards at the beginning of the game. Then, players use three cards from their own deck to tell a story. At the end, each player votes for the best story (players cannot vote for themselves). The players who gain more votes win. There could be more than one winner.

Game components

The Cards

Each cards has a front and a back. The front of the card displays a picture, while the back include some textual information. Both sides of each card have the same title, number and colour code. Each card has one of four colours: (1) Red coded spheres which contain historical information, (2) Green cards with scientific information, (3) Blue cards with design related information, and (4) Orange cards specifically related to books displayed within the bookcase.

The Coins

At the beginning of the game each player has 15 silver coins (value of 1) and 4 golden coins (value of 5), for a total value of 35.

The Winning Tile

Each player has 1 winning tile, which is used at the end of the game to vote for the best storyteller.

The Central Board

At the centre of the table is located a board displaying Dyrham bookcase. As the storytellers tell their story, they will place their cards on the top of the board in the preferred order and location.

Playing the Game

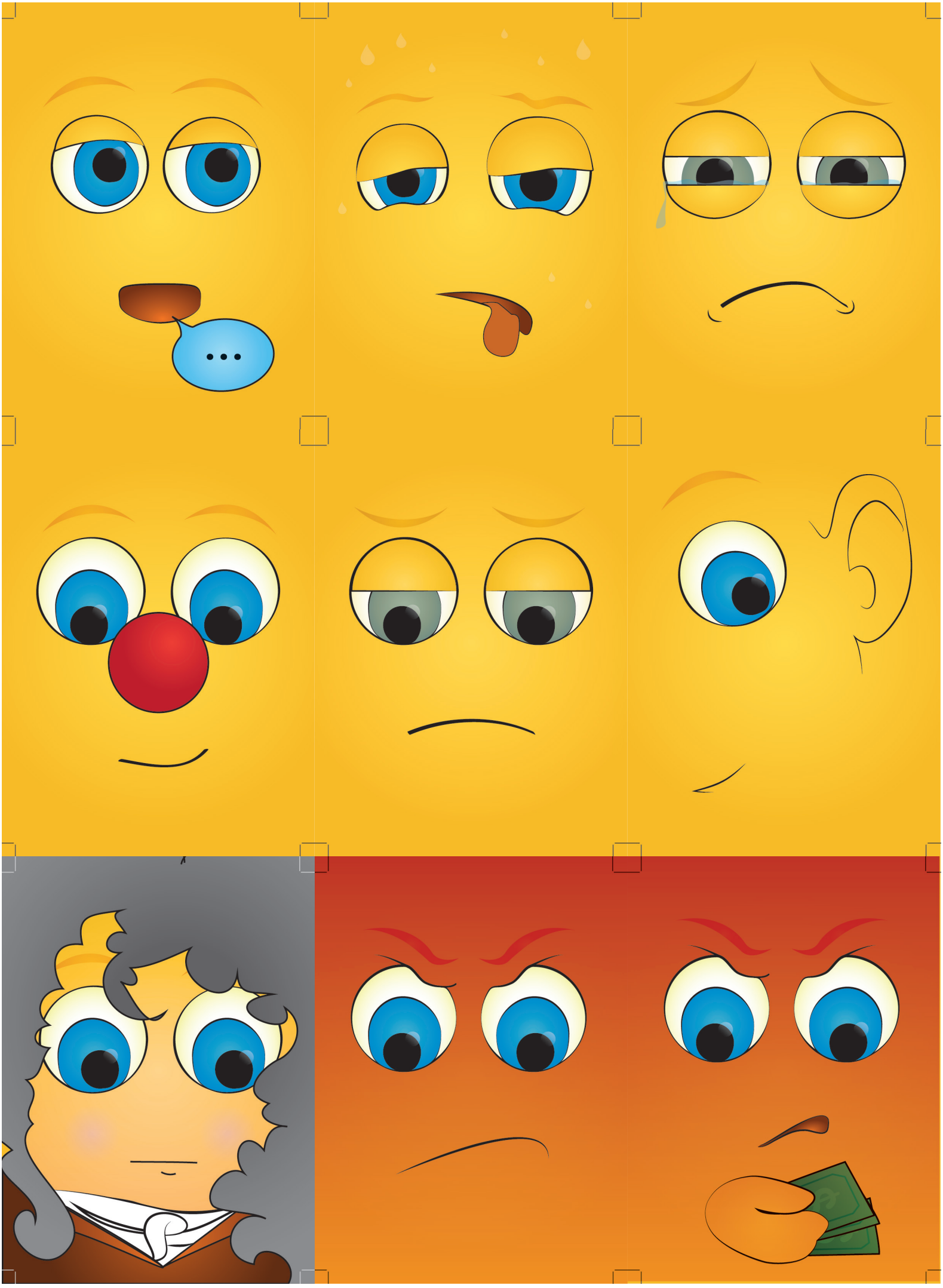
1.
The game master presents the cards one by one. For each cards players can decide to either: (1) make an offer; (2) pass; or (3) put the card on hold.
If a player makes an offer for a card, the others can either raise the offer or pass. If the majority of players are not sure weather they are interested in the card, then they can ask to put the card on a "hold" pile. At the end of the auction they can still make an offer to those cards on hold. While if every player pass on a card, then that card ends in the discard pile and it is out of the game. Each player can buy any number of cards from the game master as long as he/she has still coins to offer. However, during the telling phase, they can use just 3 cards from their deck to tell the story.

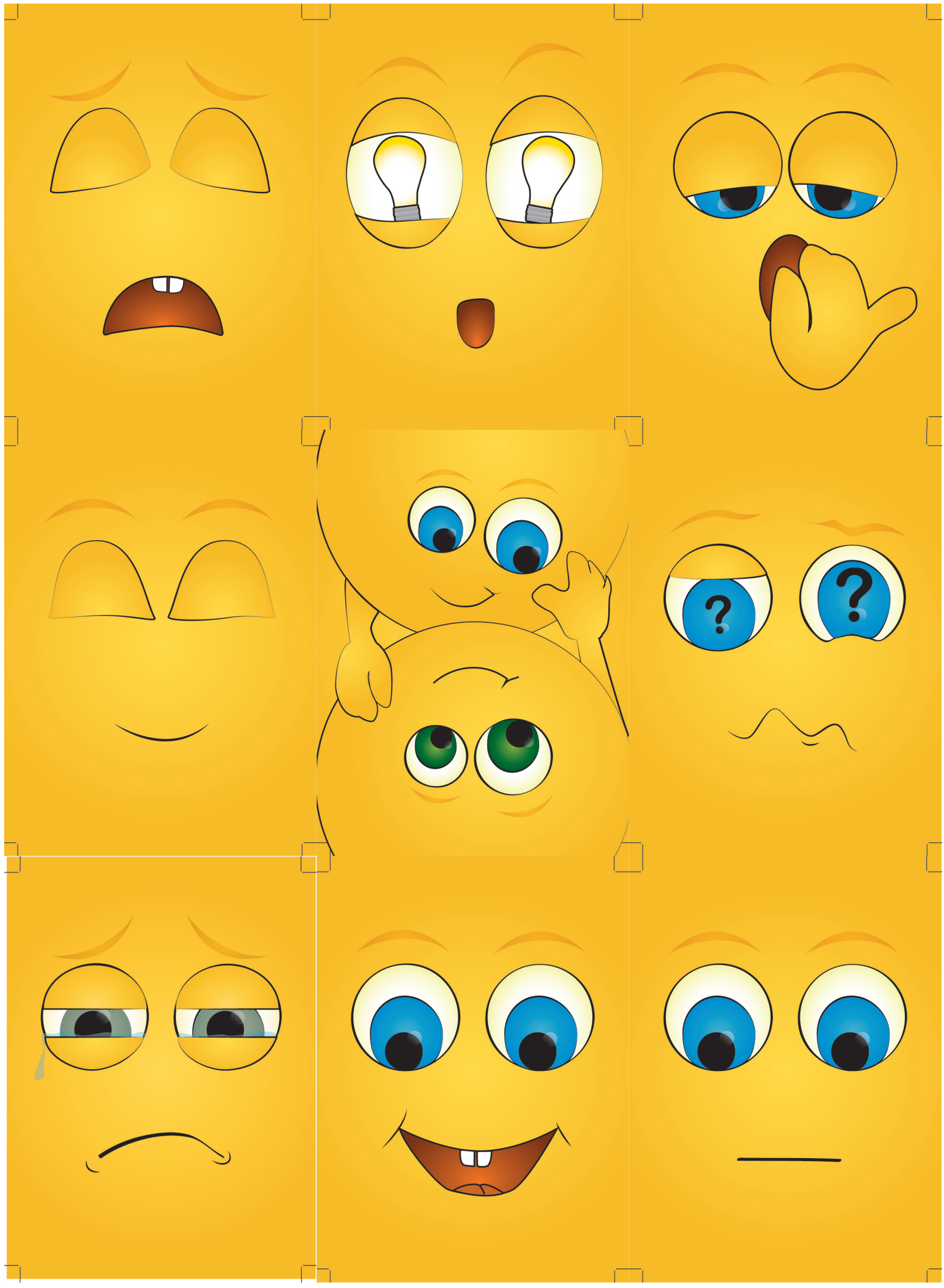
2.
Decide who will be the first storyteller. For example each player could draw a card from the discard deck, and the player whose card has the higher number goes first. The first storyteller tells a story using just 3 cards from the deck of cards s/he previously bought. S/he may tell the story in any order and using any one of the two sides of the card (whether the side with the picture or the text). Whenever s/he mentions something that is shown on one of her cards, s/he may place that card face up on the central board. Once s/he used all the 3 cards, his/her turn is finished and passed to the next teller, and so on.

3.
After all players finished their story by using 3 cards each, they can vote for the favourite story. Players can vote by giving their winning tile to the player who told the story. The players cannot vote for themselves.

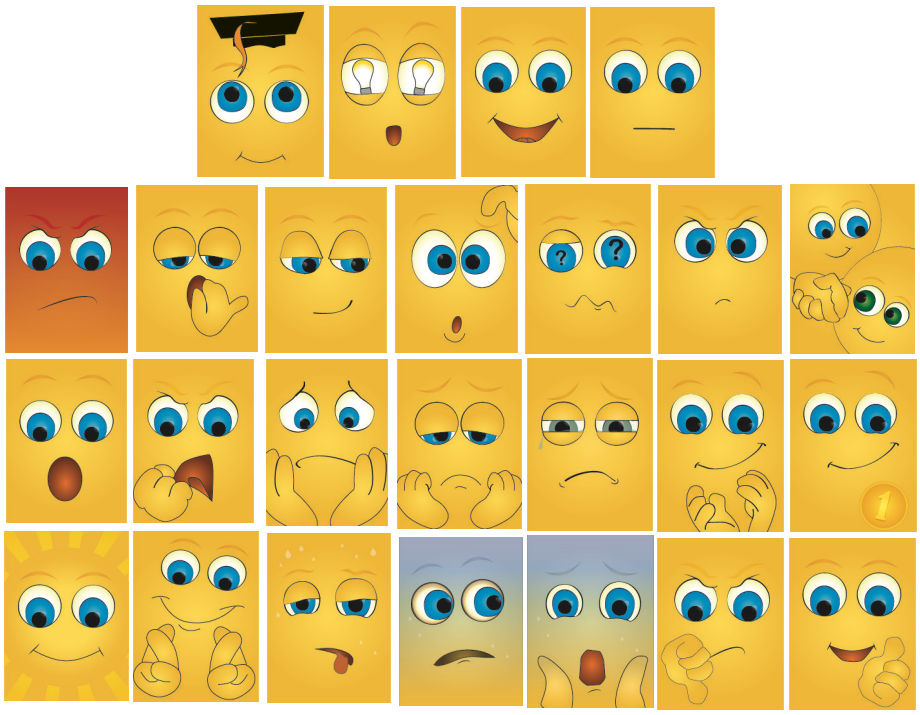
The **winner** is whoever gets more winning tiles. There could be more than one winner.

Appendix Ca: Emoji cards used during onsite word association task





Appendix Cb: Emoji designed and used during online word association task



Appendix D: Transcripts of the stories collected from each participant [T] during the four game sessions with Tell-A-Dyrham-Tale at Dyrham Park.

Game 1

[T1] Once upon a time there was a very special place and that special place was Dyrham Park and inside Dyrham Park there were millions and millions of oak trees. But what was very special about these trees was that there was a man – his name was John Mallet - and he used to cut down these trees and build bookcases.

[T2] Once upon a time there was Samuel (Pepys) with a magic bookcase and behind it there was William. Why is William hidden there? Well, William was not hidden but trapped there!

[T3] Once there was a man called William Blathwayt (…). He had a library that was very very special and well decorated

[T4] 1659 was a special year because Mary moved into a new house. What she did not know is that there were zombies hidden in the attic. That is how Mary started fighting zombies

[T5] Once upon a time there were two bookcases. Tom Povey stole one of the bookcases. The other bookcase was sold instead.

[T6] Once there was a man called Charles II. He owned (V&A) museum in London and there were lots and lots of bookcases in that museum that were from Dyrham Park. The inventors of the bookcases designed them with lots of acanthus and roses.

Game 2

[T7] She commented before: "My story is not a very good story". My story is about uncle Tom who saw Samuel Pepys' library and thought it was a very good idea to have one of those but he decided that he was not only going to make bookshelves. He was going to commission this man (Simpson) to make bookshelves with lots of secret clues about treasures that might be in somewhere. And the bookshelves had hidden clues in the books about where the treasures were buried. But then after he died he did not tell anybody. So then the bookshelf end up in the V&A museum so you can now find the treasure.

[T8] King Charles II banned the book the 'Art of War' to support his campaign the polite way of living when he was living in Dyrham Park. He got the professional joiner Thomas Simpson to make a copy of the original English bookshelf and would have had decorated with traditional English design acanthus and roses.

[T9] The Prince d'Orange decided he was going to start up a collection and so he bought what turns out to be the very first ever bookcase. When he opened it up there was a copy of Aristotle's' physics on it and it started glowing and shaking. And he opened it up and turned out it was written with magic ink and because previously the bookcase have been call just a glass press the magic had not worked and it wasn't till they worked out it was a bookcase that it come to live.

Game 3

[T10] There was a place called Dyrham Park and someone called Thomas come but he did not know that someone, he was an antique dealer called Mallet, was hunting the place. And he took, and he took a dictionary off of the glazing. Thomas was reading the dictionary and did not notice that mallet was behind him … and then he got captured.
Mallet was hunting the place because he was living here but then he died in a fire. Then the house was build again.

[T11] Samuel Pepys was married to Mary Winter and they lived in Dyrham Park. Thomas Sympson was a master joiner at the dockyards nearby. Simpson fancy Mary and Samuel found out the Simpson fancy Mary, so he put lot of tanning in his tea. But what he did not realize is that Mary drinks the tea instead of Thomas Sympson. So she felt asleep in her priceless interior … and she can be still found sleeping there today.
Comments:
[T10: wow]
[T11]: oh yes, we have to look for her later in the house!

Game 4

[T12] Mary Winter was the heir of Dyrham Park, she lived there all her life. When she was a very little girl, in the garden there was her favorite oak tree. She used to climb it and to always fell out of it as well. Luckily, there was always a big pile of leaves underneath, so when she felt, she never hurt herself. And as she grew older and older, she would go up till the top of the oak tree because from there she could see the entire valley. She could see the dark and smoke of the factories because they were building boats over there. She could see over to Bath – that was not quite as grandee back then – but there was so much building over there. They were always building new buildings. As Mary grew older, she stopped climbing and start sitting underneath her favorite tree. Just after she got married, when she was 36 years old, there was a big storm and it hit the oak three. When she went out to see the next day she was so say because her tree have been bit by the lighting and had fallen into the ground. She could not sit underneath anymore, nobody else could climb it anymore. Her new husband, he though what he could do. He though to plant a new tree but it would be small and nobody could climb it or sit under his shade. So he went and hired the best joiner he could find, T. Simpson. He brought Thomas Simpson in Dyrham Park in great secret, and he said: Could you take all this oak

wood…I will have all the wood prepared and I want you to make something amazing. So T.S. though and though what he could do for her that would remind her of her tree and be beautiful. He worked and worked, and nobody could see what he was creating. A year later – it was a big tree, there was a lot carving - he unveiled his creation. William Blathwayt went up the hill where the oak tree stood and up there, there was the most amazing chair that was carved like a throne, 10 ft high with stairs and owls carved. She could climb the stairs and sit on it under the shades.

[T13] Once, way back in 1653, there was a man called Samuel Pepys. And this was just after the time of William Shakespeare. So people were really really interested in stories. And Samuel Pepys really like stories. So what he did, is he kept a diary and in his diary he wrote what he have been doing, people he have been seeing, and just noted down everything, no matter how mundane or ordinary. But the reason why he kept a diary is because he really liked stories, so he also had a really good library to keep all the books he loved. So there were shelves dedicated to stories about dragons, stories about kings, there was a shelf full of dictionaries. He had French dictionaries and English dictionaries, so many dictionaries on the shelf. It was a huuuge bookcase, it took almost the whole of his sitting room. People would come over to visit and they would be scared in case there was some sort of earthquake, because if there was, they would be buried under in all of his books, he had so many. Few years later, after Samuel Pepys had died, his house was preserved, so people looking up to his bookcases and the V&A museum was set up and they decided they would like to re-create Pepys bookcase in the museum. Now, they could not move his original bookcase, because it was already owned by a private family, and they could not afford to buy it. What they could do it they could pay this man (John Mallet) to re-create a copy of Pepys library. In order to do so, he had to explore how Pepy's library looked like, so he went down and he noted down every book Pepy's had in his collection. And he had to re-construct the bookcase as well, so he had to take all books off the shelves to work out exactly how it would be made. But while he was doing this, John Mallet discover something. Behind the shelves of dictionaries there were lots and lots of little holes. So he gently pressed one of these holes behind the shelves and he discovered there was a fake back. He moved away this piece of wood and behind this piece of wood there was a whole other shelf and these shelves were filled with stories about Spiderman. No one knew that Spiderman had existed and how it looked like. They though Spiderman existed in the 50s and they discovered that Pepys was friend with Spiderman but society was not ready to know about superheroes yet so Pepy's diaries about Spiderman had to stay hidden and it wasn't until the V&A museum commissioned this bookcase that the stories of 16th century Spiderman with his swords and shield was discovered. It was a very special story that just Samuel Pepys knew.

[T14] William Blathwayt was a really rich man. He lived in England in 16th century and he spent lots of his early years looking for a wife that happen to have a big estate that he could marry. One day he was lucky enough to find such wife who had Dyrham Park so he married and got this beautiful big house. One thing he did not have was a library. He wanted something to keep he books. He was really interested in reading because long time ago, when he was just a young man looking for a wife

he did a trip to the Netherlands. In the Netherlands he med a Dutch historian who taught him lot of stories about Prince d'Orange, who was actually a Dutch comedian who spend lot of time telling jokes on stage and that historian he met told him everything about Prince d'Orange and wrote down all these stories which W. B. felt in love with. Since then, he though that books are something everyone should have and if was going to have them inside the house, he was going to have a really good bookcase. So he had a wonderful bookcase made for him and he kept all his books on it. When all of his friends come to visit, they could see all the wonderful books. And he said: You know what?! I am happy you like these books because I think we should pass an act of parliament to be sure that everybody has have to have books. So that how it happens that from that day onwards, everybody had a bookcase.

Appendix E: Groups of meaning

G1	G2	G3	G4	G5	G6	G7
agreement, applause, approval, supportive, clapping, congratulations, consent, yay, OK, thumbs up, great, positive, good	gloomy, glum, sad, sadness, unhappiness, unhappy, cry, crying, depressed, dismal, blue, melancholic, nostalgic distraught, mopey, loss, unsatisfied, discontent	hopes, hoping, hopeful, wishful, wish, anticipation	gloating, happiness, happy, joy, content, not angry, smile, smiling, chuffed, cheerful, cheery, chipper, sunny, sun, shining, glowing, droll	dislike, disagree, disapprove, no, negative, not pleased, no good, bad	bored, boring, yawn	baffled, befuddled, bemused, confused, lost, nonplussed, perplexed, perplexity, puzzled, questioning, stuck, doubtful, doubts, interrogation, perplexed, question, questions, skeptical, disbelief, doubtful, doubts, unsettled, unsure, dazed,dazzled, troubled, struggle, uncertain, misunderstands

G8	G9	G10	G11	G12	G13	G14
exhausted, knackered, weary, tired, sleepy, weak, drained	anger, angry, furious, infuriated, outraged, rage, anger, angry, frustration, furious, infuriated, outrage, rage, temper, annoyed, grumpy, irritated, exasperated, disgruntle, fedup	admiring, friend, friendly, friends, intimate, light, supportive, helpful, help, relationship, love, caring, motherly, conforting, sympathetic, solidarity, company, friendship, relationship, social	amazed, astonished, awe, wow, surprise, surprised, Incredulous, speachless, shocked, shock	sick, ill, sweat, dizzy	bright, clever, intelligent, ready, prepared, smart, intellect, wise	disgust, disgusted

G15	G16	G17	G18	G19	G20	G21
reflection, reflecting, contemplating, thinking, thought, think, pondering, thoughful	idea, ideas, understand, eureka, revelation, innovation, creativity, enlightenment	Deal, handshake, greetings, meet	Winner, award, first, best, cool	hurt, throw, upset, agitated, emotional, disappointed, stressed, bummer, overwhelmed, pressured	afraid, fright, panic, scared, panicked, scared, shocked, terrified, fear, fearful, fright, panic, horrified, scream	concentrated, focused, pay attention, listen, listening, hear, hearing, interested

G22	G23	G24	G25	G26	G27	G28
apprehensive, concerned, uneasy, worried, worry, agitated, anxious, eager, distressed	relax, quiet, serenity, serene, peace, comfortable, contentment, cosy	day, future, morning, night, time, on time, puntual	Grin, smirk, sly, flirt, full of oneself, showoff, crafty	apprehensive, uncomfortable, uneasy, aggravated	baby, child, childlike, childness, young, pure, todler	Proud, cheeky, cocky, content, smug, satisfied, fulfilled

G29	G30	G31	G32	G33	G34	G35
Luck, good luck, finger crossed	betrayal, deceived	fun, funny, excitement, excited, entertained, enjoyment, engaged, chuffed, pleased, clown, comedy, humorous	laught, laughting, hilarious	Mad, crazy, goofy, silly	gluttonous, greedy, mean, money, desire	Neutral, fine, indifferent, indifference, no emotion, blank, apathetic, smooth

G36	G37	G38	G39	G40	G41	G42
interested, curious, inquisitive, intrigued, interesting, impressed	Sweet, huggable, nice, cute, warm, cosy	Fight, bellicose	historical, old, lord, 19century, 18th century, king, beethoven, W. Blathwayts, traditional, renaissance	whining, complain, complaining, wailing, bewail	impatient,no patience, in a rush, in a hurry, no time, press for time, deadline, late	money, rich, lot of money, won lottery, lucky, millionaire, enterpreneur, Ferrari

G43	G44	G45
playful, game, games, gaming, cards, poker, magic	poker face, plan, planning, strategy, bluff, good hand, gamble	scholar, professor, book, teacher, study, library, reading, graduated, education, educated, knowledge, graduate, intellectual, accomplishment, achievement, achievements, completed, learning, studious, university, learning, undergrad

Appendix F: Frequency (Freq), proportion of frequency (prop.Freq/36), and Confidence Intervals (CI) analysis for each emoji (X) and group of meaning (Y) from the onsite task. All Frequencies equal to zero were excluded

t.x	t.y	t.Freq	prop.Freq/36	CI low	CI high
A	G1	1	0.0278	0	0.14
B1	G10	1	0.0278	0	0.14
B3	G10	1	0.0278	0	0.14
B5	G10	1	0.0278	0	0.14
Q1	G10	16	0.4444	0.27	0.61
B1	G11	2	0.0556	0	0.18
B3	G11	2	0.0556	0	0.18
C	G11	3	0.0833	0.01	0.22
O	G11	1	0.0278	0	0.14
O1	G11	1	0.0278	0	0.14
O	G12	1	0.0278	0	0.14
V	G12	8	0.2222	0.1	0.39
B5	G13	1	0.0278	0	0.14
S	G13	5	0.1389	0.04	0.29
S2	G13	4	0.1111	0.03	0.26
V	G14	3	0.0833	0.01	0.22
B5	G15	2	0.0556	0	0.18
C	G15	3	0.0833	0.01	0.22
H2	G15	1	0.0278	0	0.14
S1	G15	1	0.0278	0	0.14
A	G19	4	0.1111	0.03	0.26
C	G19	1	0.0278	0	0.14
H	G19	4	0.1111	0.03	0.26
H1	G19	2	0.0556	0	0.18
K2	G19	1	0.0278	0	0.14
V1	G19	2	0.0556	0	0.18
A	G2	6	0.1667	0.06	0.32
A1	G2	1	0.0278	0	0.14
A2	G2	1	0.0278	0	0.14
C	G2	5	0.1389	0.04	0.29
H	G2	21	0.5833	0.4	0.74
H1	G2	13	0.3611	0.2	0.53
H2	G2	7	0.1944	0.08	0.36
K2	G2	6	0.1667	0.06	0.32
N	G2	1	0.0278	0	0.14
O	G2	2	0.0556	0	0.18
S2	G2	1	0.0278	0	0.14
V	G2	1	0.0278	0	0.14
V1	G2	1	0.0278	0	0.14
C	G20	1	0.0278	0	0.14
H	G20	1	0.0278	0	0.14
O	G20	1	0.0278	0	0.14
V1	G20	7	0.1944	0.08	0.36
B4	G21	1	0.0278	0	0.14
B5	G21	1	0.0278	0	0.14

t.x	t.y	t.Freq	prop.Freq/36	CI low	CI high
S1	G21	1	0.0278	0	0.14
S2	G21	6	0.1667	0.06	0.32
Z	G21	14	0.3889	0.23	0.56
A	G22	2	0.0556	0	0.18
A1	G22	1	0.0278	0	0.14
A2	G22	1	0.0278	0	0.14
H	G22	2	0.0556	0	0.18
H2	G22	4	0.1111	0.03	0.26
O	G22	2	0.0556	0	0.18
O1	G22	1	0.0278	0	0.14
V1	G22	6	0.1667	0.06	0.32
Z	G22	1	0.0278	0	0.14
G1	G23	10	0.2778	0.14	0.45
O1	G23	1	0.0278	0	0.14
S2	G23	2	0.0556	0	0.18
A2	G24	4	0.1111	0.03	0.26
K2	G24	2	0.0556	0	0.18
N	G24	5	0.1389	0.04	0.29
O	G24	1	0.0278	0	0.14
V1	G24	4	0.1111	0.03	0.26
B3	G25	1	0.0278	0	0.14
B1	G27	8	0.2222	0.1	0.39
B2	G27	1	0.0278	0	0.14
B3	G27	8	0.2222	0.1	0.39
K2	G27	2	0.0556	0	0.18
Q1	G27	1	0.0278	0	0.14
S1	G27	1	0.0278	0	0.14
Z	G27	1	0.0278	0	0.14
G1	G28	2	0.0556	0	0.18
S	G28	5	0.1389	0.04	0.29
B2	G3	1	0.0278	0	0.14
S	G3	1	0.0278	0	0.14
Z	G3	1	0.0278	0	0.14
A	G30	2	0.0556	0	0.18
B1	G31	4	0.1111	0.03	0.26
B2	G31	18	0.5	0.32	0.67
B3	G31	4	0.1111	0.03	0.26
B4	G31	1	0.0278	0	0.14
B5	G31	2	0.0556	0	0.18
S1	G31	1	0.0278	0	0.14
S2	G31	1	0.0278	0	0.14
B1	G32	1	0.0278	0	0.14
B3	G32	1	0.0278	0	0.14
A	G33	1	0.0278	0	0.14
B1	G33	1	0.0278	0	0.14
B3	G33	1	0.0278	0	0.14

t.x	t.y	t.Freq	prop.Freq/36	CI low	CI high
B4	G33	1	0.0278	0	0.14
A1	G34	7	0.1944	0.08	0.36
B1	G34	2	0.0556	0	0.18
B2	G34	1	0.0278	0	0.14
B3	G34	2	0.0556	0	0.18
B4	G34	9	0.25	0.12	0.42
H2	G34	11	0.3056	0.16	0.48
K2	G34	1	0.0278	0	0.14
C	G35	4	0.1111	0.03	0.26
H1	G35	2	0.0556	0	0.18
O1	G35	3	0.0833	0.01	0.22
S1	G35	2	0.0556	0	0.18
B1	G36	1	0.0278	0	0.14
B3	G36	1	0.0278	0	0.14
B5	G36	1	0.0278	0	0.14
C	G36	1	0.0278	0	0.14
O1	G36	1	0.0278	0	0.14
S1	G36	1	0.0278	0	0.14
Z	G36	3	0.0833	0.01	0.22
B2	G37	1	0.0278	0	0.14
G1	G37	2	0.0556	0	0.18
Q1	G37	7	0.1944	0.08	0.36
B5	G39	1	0.0278	0	0.14
S1	G39	12	0.3333	0.18	0.5
A	G4	1	0.0278	0	0.14
B1	G4	11	0.3056	0.16	0.48
B2	G4	4	0.1111	0.03	0.26
B3	G4	9	0.25	0.12	0.42
B4	G4	9	0.25	0.12	0.42
B5	G4	1	0.0278	0	0.14
C	G4	2	0.0556	0	0.18
G1	G4	9	0.25	0.12	0.42
Q1	G4	4	0.1111	0.03	0.26
S	G4	5	0.1389	0.04	0.29
Z	G4	4	0.1111	0.03	0.26
K2	G40	4	0.1111	0.03	0.26
O1	G40	1	0.0278	0	0.14
A2	G41	12	0.3333	0.18	0.5
V1	G41	7	0.1944	0.08	0.36
B4	G42	12	0.3333	0.18	0.5
B5	G43	13	0.3611	0.2	0.53
Q1	G43	1	0.0278	0	0.14
B5	G44	9	0.25	0.12	0.42
S	G45	18	0.5	0.32	0.67
S1	G45	3	0.0833	0.01	0.22
S2	G45	13	0.3611	0.2	0.53

t.x	t.y	t.Freq	prop.Freq/36	CI low	CI high
Z	G45	1	0.0278	0	0.14
A	G5	1	0.0278	0	0.14
A1	G5	1	0.0278	0	0.14
A2	G6	1	0.0278	0	0.14
H1	G6	1	0.0278	0	0.14
N	G6	6	0.1667	0.06	0.32
V	G6	2	0.0556	0	0.18
A1	G7	1	0.0278	0	0.14
B5	G7	1	0.0278	0	0.14
C	G7	5	0.1389	0.04	0.29
H1	G7	1	0.0278	0	0.14
H2	G7	1	0.0278	0	0.14
O	G7	21	0.5833	0.4	0.74
O1	G7	25	0.6944	0.51	0.83
V	G7	2	0.0556	0	0.18
G1	G8	2	0.0556	0	0.18
H1	G8	4	0.1111	0.03	0.26
H2	G8	2	0.0556	0	0.18
K2	G8	7	0.1944	0.08	0.36
N	G8	19	0.5278	0.35	0.69
V	G8	12	0.3333	0.18	0.5
V1	G8	1	0.0278	0	0.14
A	G9	10	0.2778	0.14	0.45
A1	G9	16	0.4444	0.27	0.61
A2	G9	10	0.2778	0.14	0.45
B2	G9	1	0.0278	0	0.14
H1	G9	2	0.0556	0	0.18
K2	G9	3	0.0833	0.01	0.22
N	G9	1	0.0278	0	0.14
V	G9	3	0.0833	0.01	0.22

Appendix G: Frequency (Freq), proportion of frequency (prop.Freq/35), and Confidence Intervals (CI) analysis for each emoji (X) and group of meaning (Y) from the online task. All Frequencies equal to zero were excluded.

t.x	t.y	t.Freq	prop.Freq/35	CI low	CI high
B	G1	1	0.02857143	0	0.14
C	G1	2	0.05714286	0	0.19
G	G1	15	0.42857143	0.26	0.6
J	G1	1	0.02857143	0	0.14
Q	G1	2	0.05714286	0	0.19
Y	G1	22	0.62857143	0.44	0.78
G	G10	2	0.05714286	0	0.19
I	G10	1	0.02857143	0	0.14
Q	G10	18	0.51428571	0.33	0.68
Y	G10	1	0.02857143	0	0.14
C	G11	3	0.08571429	0.01	0.23
G	G11	1	0.02857143	0	0.14
P	G11	2	0.05714286	0	0.19
U	G11	2	0.05714286	0	0.19
U1	G11	3	0.08571429	0.01	0.23
W	G11	29	0.82857143	0.66	0.93
O	G12	3	0.08571429	0.01	0.23
U	G12	2	0.05714286	0	0.19
U1	G12	3	0.08571429	0.01	0.23
V	G12	17	0.48571429	0.31	0.66
D	G13	1	0.02857143	0	0.14
R	G13	1	0.02857143	0	0.14
S	G13	12	0.30769231	0.19	0.53
W	G13	1	0.02857143	0	0.14
C	G15	1	0.02857143	0	0.14
E	G15	1	0.02857143	0	0.14
P	G15	4	0.11428571	0.03	0.26
R	G16	25	0.71428571	0.53	0.85
Q	G17	10	0.28571429	0.14	0.46
F	G18	8	0.22857143	0.1	0.4
G	G18	2	0.05714286	0	0.19
A	G19	1	0.02857143	0	0.14
D	G19	2	0.05714286	0	0.19
H	G19	6	0.17142857	0.06	0.13
L	G19	4	0.11428571	0.03	0.26
T	G19	2	0.05405405	0	0.19
U	G19	2	0.05714286	0	0.19
V	G19	1	0.02857143	0	0.14
A	G2	1	0.02857143	0	0.14
B	G2	1	0.02857143	0	0.14
C	G2	2	0.05714286	0	0.19
D	G2	1	0.02857143	0	0.14
E	G2	1	0.02857143	0	0.14
F	G2	1	0.02857143	0	0.14
H	G2	26	0.74285714	0.56	0.87

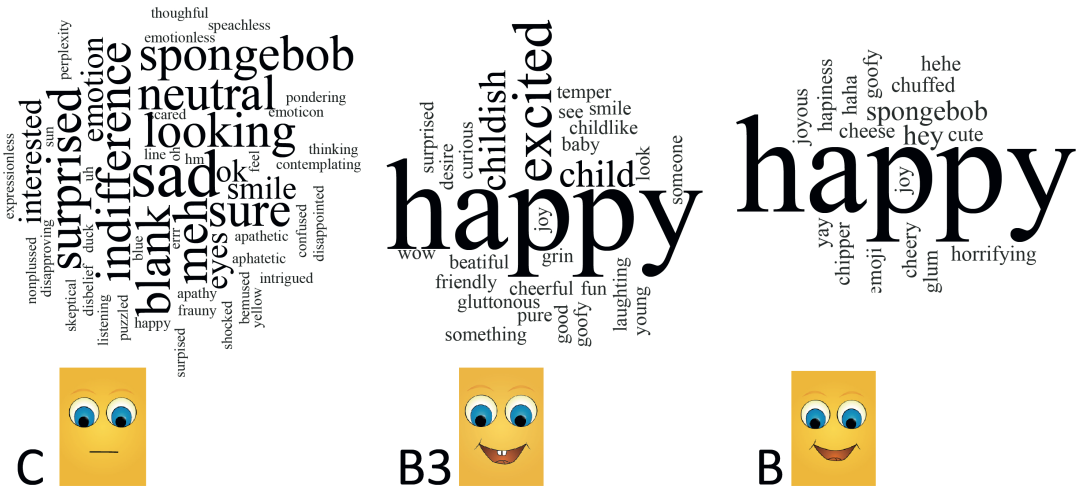
t.x	t.y	t.Freq	prop.Freq/35	CI low	CI high
L	G2	15	0.42857143	0.26	0.6
M	G2	1	0.02857143	0	0.14
O	G2	1	0.02857143	0	0.14
S	G2	1	0.02564103	0	0.14
T	G2	4	0.10810811	0.03	0.26
U	G2	3	0.08571429	0.01	0.23
U1	G2	1	0.02857143	0	0.14
V	G2	1	0.02857143	0	0.14
B	G20	1	0.02857143	0	0.14
L	G20	1	0.02857143	0	0.14
U	G20	13	0.37142857	0.21	0.55
U1	G20	17	0.48571429	0.31	0.66
A	G22	1	0.02857143	0	0.14
D	G22	1	0.02857143	0	0.14
G	G22	1	0.02857143	0	0.14
L	G22	8	0.22857143	0.1	0.4
U	G22	1	0.02857143	0	0.14
U1	G22	2	0.05714286	0	0.19
V	G24	1	0.02857143	0	0.14
E	G25	8	0.22857143	0.1	0.4
F	G25	5	0.14285714	0.04	0.3
G	G25	1	0.02857143	0	0.14
M	G26	1	0.02857143	0	0.14
U	G26	1	0.02857143	0	0.14
V	G26	1	0.02857143	0	0.14
S	G27	1	0.02564103	0	0.14
E	G28	15	0.42857143	0.26	0.6
F	G28	11	0.31428571	0.16	0.49
G	G28	1	0.02857143	0	0.14
S	G28	2	0.05128205	0	0.19
J	G29	18	0.51428571	0.33	0.68
Q	G29	1	0.02857143	0	0.14
Y	G29	1	0.02857143	0	0.14
J	G3	10	0.28571429	0.14	0.46
F	G31	2	0.05714286	0	0.19
G	G31	2	0.05714286	0	0.19
W	G31	1	0.02857143	0	0.14
Y	G31	1	0.02857143	0	0.14
B	G33	1	0.02857143	0	0.14
D	G33	1	0.02857143	0	0.14
M	G33	1	0.02857143	0	0.14
C	G35	12	0.34285714	0.19	0.52
E	G35	1	0.02857143	0	0.14
C	G36	2	0.05714286	0	0.19
G	G36	1	0.02857143	0	0.14
O	G36	1	0.02857143	0	0.14

t.x	t.y	t.Freq	prop.Freq/35	CI low	CI high
P	G36	2	0.05714286	0	0.19
R	G36	1	0.02857143	0	0.14
M	G38	3	0.08571429	0.01	0.23
B	G4	23	0.65714286	0.47	0.8
C	G4	1	0.02857143	0	0.14
E	G4	1	0.02857143	0	0.14
F	G4	4	0.11428571	0.03	0.26
G	G4	3	0.08571429	0.01	0.23
I	G4	33	0.94285714	0.8	0.99
J	G4	3	0.08571429	0.01	0.23
S	G4	2	0.05128205	0	0.19
Y	G4	8	0.22857143	0.1	0.4
R	G45	1	0.02857143	0	0.14
S	G45	17	0.43589744	0.31	0.66
C	G5	1	0.02857143	0	0.14
D	G5	1	0.02857143	0	0.14
T	G5	21	0.56756757	0.42	0.76
L	G6	1	0.02857143	0	0.14
N	G6	14	0.4	0.23	0.57
C	G7	5	0.14285714	0.04	0.3
D	G7	4	0.11428571	0.03	0.26
H	G7	1	0.02857143	0	0.14
L	G7	1	0.02857143	0	0.14
O	G7	27	0.77142857	0.59	0.89
P	G7	24	0.68571429	0.5	0.83
U	G7	1	0.02857143	0	0.14
U1	G7	1	0.02857143	0	0.14
V	G7	1	0.02857143	0	0.14
N	G8	19	0.54285714	0.36	0.71
O	G8	1	0.02857143	0	0.14
U1	G8	1	0.02857143	0	0.14
V	G8	8	0.22857143	0.1	0.4
A	G9	30	0.85714286	0.69	0.95
D	G9	15	0.42857143	0.26	0.6
M	G9	23	0.65714286 6	0.47	0.8
T	G9		0.16216216	0.06	0.33

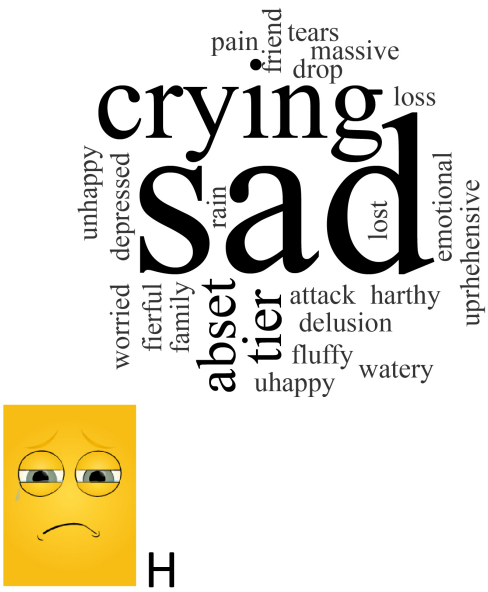
Appendix H: Word clouds illustrating word frequency and comparison between word clouds

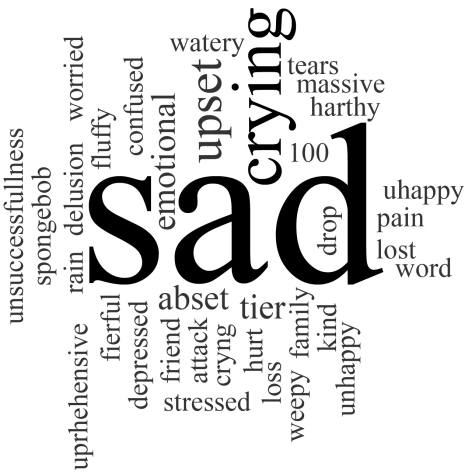
Comparison between emoji illustrating anger and fight (online task)

Comparison between emoji illustrating neutral, happy (onsite task) and happy (online task)

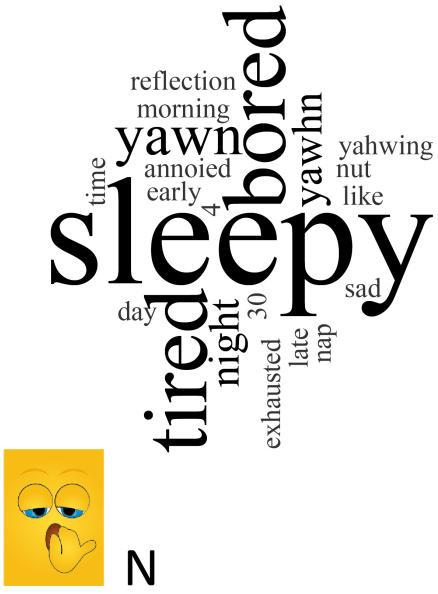


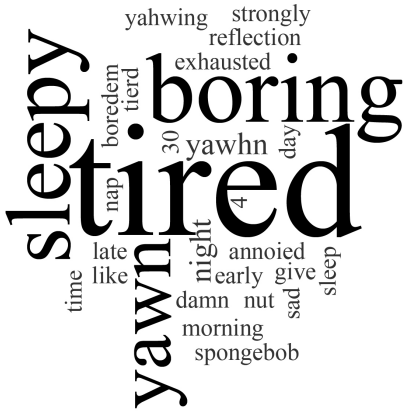
Emoji illustrating sadness from onsite (left) and online task (right)



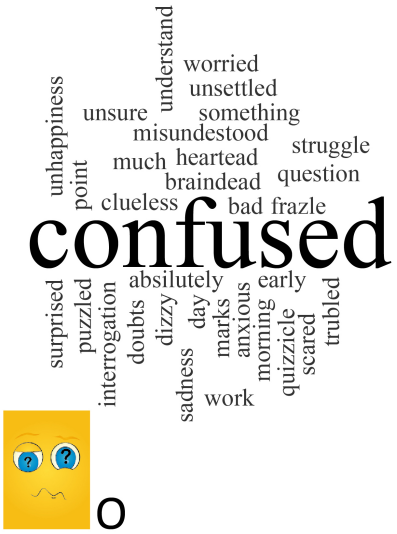


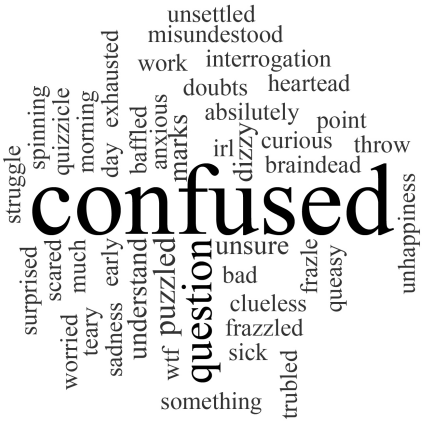
Emoji illustrating boredom from onsite (left) and online task (right)





Emoji illustrating confusion from onsite (left) and online task (right)





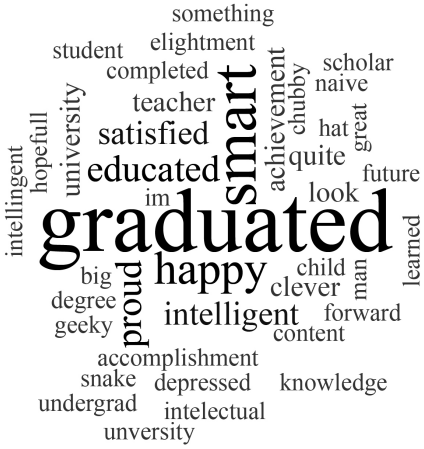
O

Emoji illustrating confusion from onsite (left) and online task (right)

R

Emoji illustrating achievement from onsite (left) and online task (right)

S

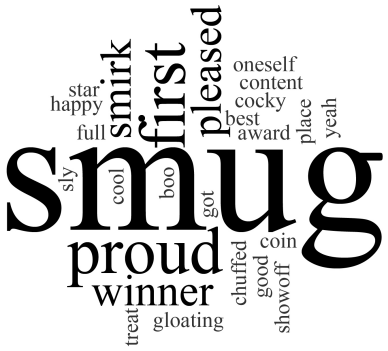


Emoji illustrating fatigue/physical tiredness from onsite (left) and online task (right)

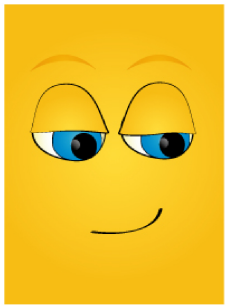
V

Emoji illustrating proud (top), smirk (center), and congratulate (bottom) from online task

F



E



G

Appendix I: Transcript interviews with participants (T) who interacted with the Sandbox. The transcripts were made by [redacted], a Masters student whom I was supervising.

T1:

1. You used the sandbox to fulfil the mission. Was it all clear? Any questions? After you used this system, are there anything you don't understand yet or anything confusing you?

Yes, I think I basically have finished the task, but the sand is kind of difficult to handle.

2. Do you know what you just did? After you used this system, do you know its function or usage?

   Can you simply describe its main purposes that you have understood?

I am not very sure, maybe it is used as a tool to show people to represent different positions of geography situations in true life. It is mainly used to form framework of combinations of different factors for a specific purpose.

3. When you used this sandbox, how you felt about this sandbox? (Difficult /excited /enjoy /curious /impatient) Did you enjoy? Why?

Pretty interesting. I enjoyed it but also some difficulties.

4. Before you started the task/ During the task/ After you accomplished the task, I found you spend more time on interacting with the sand. Why? Because you did not understand how to accomplish the task/you just wanted to verify whether your work is accurate or not, or you were just having fun with it?

Because it is the tool I used to finish the task. I did not spend much time to verify. I had fun with that.

5. In task 1, do you think you did well? / your work was good?

Pretty well, just so so.

6. In task 2, do you think you actually improved the work you built in task 1?

Yeah

7. So, if I show you a topographical map now, do you think you could understand it?

(Show a difference and ask questions – contour lines, watersheds, colour means) Do you need additional information to understand it? What kind of information you need?

Yes, using geographical knowledge. Different lines represent different hight.

8. During the task, you asked us for help/asked us some questions. Why? Because these questions bothered you to complete the task or you were just interested in these questions?

I want to make sure of the task and I can know what exactly I have to do.

9. Do you think whether the projection / label can help you better understand a topographical map (the contour lines, watersheds, catchment areas, levees, etc.)? / How would you improve it? (Projection / label)

Yes, it would be more directly for me to understand different hight of the tropical map representing.

10. Suppose that you want to learn some earth science, do you think the sandbox can facilitate you to better understand and learn these knowledge? Or would you prefer a book, a paper map or something else?

Yes. It is more useful because users can performance by themselves and understand the problem better.

11. What did you like or dislike of the sandbox? For example, there was something particularly confusing/irritating?

It is interesting but hard to handles and the hight may be difficult to estimate.

12. Would you like to play the sandbox with your friends? Or you just want to play alone? Why? (Social experience)

I prefer play by myself and I can follow my own ideas.

13. After the task, how do you feel? Do you feel maybe a little tired?

I feel good and learn a lot from it but also a little tired because it is new to me.

T2:

1. You used the sandbox to fulfil the mission. Was it all clear? Any questions? After you used this system, are there anything you don't understand yet or anything confusing you?

No, I don’t. I don’t really understand the meaning of different colours. The green means mountains, but I can’t get what the yellow and red represent for.

Me: The colours show the differences of altitude. The blue means water, and lower places always have water.

2. Do you know what you just did? After you used this system, do you know its function or usage? Can you simply describe its main purposes that you have understood?

You just said different colours mean different altitude, so the sandbox can make it possible for me to change the altitude of different parts and finish the map you had showed to me.

3. When you used this sandbox, how you felt about this sandbox? (difficult /excited /enjoy /curious /impatient) Did you enjoy? Why?

It's not difficult to use, and it's interesting. If you change colour, you will know what it means. And you can find how to play it.

4. Before you started the task/ during the task/ After you accomplished the task, I found you spend more time on interacting with the sand. Why? Because you did not understand how to accomplish the task/you just wanted to verify whether your work is accurate or not, or you were just having fun with it?

It's my first time to experience such things. I'm curious of the sandbox, so before I started, I wanted to see how to use it.

5. In task 1, do you think you did well? / your work was good?

Yes, I feel a little satisfied, not to much. I didn't finish the whole map you gave to me, but I had almost finished it.

6. In task 2, do you think you actually improved the work you built in task 1?

Yes, I think so.

7. So, if I show you a topographical map now, do you think you could understand it? (Show a difference and ask questions – contour lines, watersheds, color means)

No, I don't think I can do it.

Me: Do you know the meaning of different colours and lines?

Yes. The lines mean different height. This line means it's 500 meters, and this part is higher and higher.

Do you need additional information to understand it? What kind of information you need?

No. if you have, I want to know further about this map. If the map is in the sandbox, I think I can know more about it.

8. During the task, you asked us for help/asked us some questions. Why? Because these questions bothered you to complete the task or you were just interested in these questions?

9. Do you think whether the projection / label can help you better understand a topographical map (the contour lines, watersheds, catchment areas, levees, etc.)? / How would you improve it? (Projection / label)

Yes, I think it's very useful. With the help of this, you know the changing of altitude through the differences of colours. For example, you want to get to the height of the red, with the sandbox you can easily know whether you have done it. It makes the view 3D, so you can know more details than a common map.

Me: When you improve the map, do you use the projection function to improve it?

Yes. With the help of sandbox, I can easily know where the river is.

10. Suppose that you want to learn some earth science, do you think the sandbox can facilitate you to better understand and learn these knowledge?

Yes, I think so.

Or would you prefer a book, a paper map or something else?

I would prefer a book and the sandbox. When I get enough acknowledge from the book, sandbox can help me make a 3D map, and give me further information of the map.

11. What did you like or dislike of the sandbox? For example, there was something particularly confusing/irritating?

It help me better understand the changing of altitude. The only thing that confused me was that I didn't know the exact height of different colours. When I used the sandbox, I had to try it.

12. Would you like to play the sandbox with your friends? Or you just want to play alone? Why? (Social experience)

I think it's interesting. I would like to play alone, but if my friends want to join me, I would like to play it with them.

13. After the task, how do you feel? Do you feel maybe a little tired?

Excited, it's very interesting.

T3:

1. You used the sandbox to fulfil the mission. Was it all clear? Any questions? After you used this system, are there anything you don't understand yet or anything confusing you?

As I mentioned before, I have the geography knowledge before, so I don't need any help to do this, but I think the lower part should not use blue, so it makes me feel like a river, but it is not a river, maybe should change other colour,

I know, it use blue, it makes me feel like a river, but it is not,

Maybe you can create a colour representing the sea level, the lower colour is below the sea level. ..It is a good system

Are all the blue above the sea level?

Oh, it is marked, it is not minors, the blue areas are 300,300 and 150 meters, it is still higher than the sea level.

2. Do you know what you just did? After you used this system, do you know its function or usage? Can you simply describe its main purposes that you have understood?

Yeah, you gave me two tasks, after two or three seconds, after I have put my hands in it and see the change of the colour, I begin to know the functions.

3. When you used this sandbox, how you felt about this sandbox? (Difficult /excited /enjoy /curious /impatient) Did you enjoy? Why?

That must be some sensors, they can sense the altitude about these sand and change the colour according to the height. You have the virtual view.

4. Before you started the task/ During the task/ After you accomplished the task, I found you spend more time on interacting with the sand. Why? Because you did not understand how to accomplish the task/you just wanted to verify whether your work is accurate or not, or you were just having fun with it?

At first, you just told us we will play the sand, but you did not tell us about how to play this, so I did what I did just now and understand the whole things, you did not tell me before, you did not have any introduction about this, so I play it and understand by myself.

5. In task 1, do you think you did well? / your work was good?

No, I don't think so, I think I need some extra sand to finish the whole task, maybe it will more similar and more accurate to the original map, since I borrow or dig some sand from other area, but the colour is not matching the height, maybe because of my bad construction ability. If you want to make it more funny or better, you can make a tour.

6. In task 2, do you think you actually improved the work you built in task 1?

I haven't, I completely ruin. I ruin the construction. I think the task 2 is about building a better place to live, I think the whole sand should be used to rebuild, creating mountain and creating river, and find a good place to live,

7. So, if I show you a topographical map now, do you think you could understand it? (Show a difference and ask questions – contour lines, watersheds, color means)

Do you need additional information to understand it? What kind of information you need?

Of course

This map is just about the height, maybe I need some color and marks.

8. During the task, you asked us for help/asked us some questions. Why? Because these questions bothered you to complete the task or you were just interested in these

questions?

I just feel confusion about this, since you just said to match the original map, if you can make me understand the map better, I can did a better job, but if not, I still can build the sand like that in the map.

9. Do you think whether the projection / label can help you better understand a topographical map (the contour lines, watersheds, catchment areas, levees, etc.)? / How would you improve it? (Projection / label)

Yes, of course, they are so interesting.

10. Suppose that you want to learn some earth science, do you think the sandbox can facilitate you to better understand and learn these knowledge? Or would you prefer a book, a paper map or something else?

Yes, you can put this system in the science museum for the children to play.

I think playing with the real sand is better. If you put the sandbox in the museum, maybe you can create the preview map in a real path, so the children can understand where it is, it will help them to understand better and build better. Just follow the map, and the children understand where the place is.

11. What did you like or dislike of the sandbox? For example, there was something particularly confusing/irritating?

I like it, the virtual view is good.

12. Would you like to play the sandbox with your friends? Or you just want to play alone? Why? (Social experience)

I prefer to play it by myself. Because it is not big enough to play with my friends, and also, if I play with my friends, I have my own ideas to copy the map and they have their own ones, I think it is not good, so I want to play alone.

13. After the task, how do you feel? Do you feel maybe a little tired?

No, I did not feel tired, when you create by yourself, you don’t need follow the map, you just need follow you heart. The task is ok.

T4:

1. You used the sandbox to fulfil the mission. Was it all clear? Any questions? After you used this system, are there anything you don't understand yet or anything confusing you?

No, I don't have question, because I can understand my task and the map.

Maybe the label makes me a little confusing, the value on the colour coordinate label is too big, -1500, it must be a river, a deep river, I think.

2. Do you know what you just did? After you used this system, do you know its function or usage?

Can you simply describe its main purposes that you have understood?

3. When you used this sandbox, how you felt about this sandbox? (difficult /excited /enjoy /curious /impatient) Did you enjoy? Why?

I think I only did a task, just a task, I think it is not interesting, I just finished the task, but I cannot control the height in the map, I just did it as l think.

4. Before you started the task/ During the task/ After you accomplished the task, I found you spend more time on interacting with the sand. Why? Because you did not understand how to accomplish the task/you just wanted to verify whether your work is accurate or not, or you were just having fun with it?

5. In task 1, do you think you did well? / your work was good?

Yes, I think I build well, but if I have a ruler to help control the height, I think I can build it better.

6. In task 2, do you think you actually improved the work you built in task 1?

Yes, I build more plain and dig the river. I think more people can live in the plain space. And the river and mountain can make the living surroundings better.

7. So, if I show you a topographical map now, do you think you could understand it? (Show a difference and ask questions – contour lines, watersheds, color means) Do you need additional information to understand it? What kind of information you need?

Yes, the green, yellow and red colors represent different levels, and the red is the highest. Yes, I think I need some information about the pink, because it looks like very deep, and I want to know what the color is really represented.

8. During the task, you asked us for help/asked us some questions. Why? Because these questions bothered you to complete the task or you were just interested in these questions?

9. Do you think whether the projection / label can help you better understand a topographical map (the contour lines, watersheds, catchment areas, levees, etc.)? / How would you improve it? (Projection / label)

Yes, I think the label is necessary, because it can help me understand which place is high or low, how? I just put the label on the right place, and using the labels to mark the places.

10. Suppose that you want to learn some earth science, do you think the sandbox can facilitate you to better understand and learn these knowledge? Or would you prefer a book, a paper map or something else?

I think it can help me understand, but it is not very useful. I like 3D maps, it can be the book map, or the electric map, such like google map.

11. What did you like or dislike of the sandbox? For example, there was something particularly confusing/irritating?

I think the system is just so-so, it is just a task.

I think the sandbox should be improved, if the sandbox can use some color to represent the altitude, I think it will be more useful.

12. Would you like to play the sandbox with your friends? Or you just want to play alone? Why? (Social experience)

Maybe I don't want to play it with my friends, because it is not interesting, maybe the children like it.

13. After the task, how do you feel? Do you feel maybe a little tired?

Maybe it is a little long, but I think it is ok.

T5:

1. You used the sandbox to fulfil the mission. Was it all clear? Any questions?

Actually, I have fun for doing the task, maybe I have some questions about, how deep the color is. I just estimate how much it's deep in the sand. But I don't know it exactly.

2. Do you know what you just did?

I know about the function, I understood what the task is

3. When you used this sandbox, how you felt about this sandbox? (difficult /excited /enjoy /curious /impatient) Did you enjoy? Why?

First, when I first see the sandbox, I think it is not difficult for me, and I quite enjoy to play with the sandbox.

4. Before you started the task/ During the task/ After you accomplished the task, I found you spend more time on interacting with the sand. Why? Because you did not understand how to accomplish the task/you just wanted to verify whether your work is accurate or not, or you were just having fun with it?

5. In task 1, do you think you did well? / your work was good?

Maybe

6. In task 2, do you think you actually improved the work you built in task 1?

Yes, because I learned about how to play with sandbox and I can estimate the deep by myself.

I created the sand.

7. So, if I show you a topographical map now, do you think you could understand it? (Show a difference and ask questions - contour lines, watersheds, color means) Do you need additional information to understand it? What kind of information you need?

I quite understand, but maybe I don't know about the sand color.

Like the strong pink color, because it didn't see in here.

I know (the different color's mean), the red color maybe means not deep, and the strong color means deep

I don't know (the numbers on this picture). And the color maybe show how it's deep.

I know (the lines mean). Yeah it means the height.

8. During the task, you asked us for help/asked us some questions. Why? Because these questions bothered you to complete the task or you were just interested in these questions?

9. Do you think whether the projection / label can help you better understand a topographical map (the contour lines, watersheds, catchment areas, levees, etc.)? / How would you improve it? (Projection / label)

I think it's useful to understand, but in my opinion, if you use the sandbox, maybe you don't choose the labels and you just show the color on the sand, it's like when I move the sand, the color will show on the sand, I think maybe it's better because I will know the exact deep when I interact with the sand.

10. Suppose that you want to learn some earth science, do you think the sandbox can facilitate you to better understand and learn these knowledge? Or would you prefer a book, a paper map or something else?

Yeah, I think so.

For me, I think maybe like this is OK, but just need the tutorial, like the handbook, it's not a thick book, just 1 or 2 pages, about what's the color.

Actually, it's a deep mean, so I think just it is OK. Because I think the sandbox is easy to understand, but when I play, I want to see it what it was……

11. What did you like or dislike of the sandbox? For example, there was something particularly confusing/irritating?

Actually I enjoy playing the sandbox, but I want to know, when I interact with the sandbox, I want to see the color, and how it's deep.

I think if the sandbox will show the color, like the strong color when user interact, maybe the user will enjoy to play, and interact more generally.

12. Would you like to play the sandbox with your friends? Or you just want to play alone? Why? (Social experience)

I think both, because I can play alone, If I invite my friends to join in the sandbox together, maybe it's better, because you can create a lot of things with sandbox.

13. After the task, how do you feel? Do you feel maybe a little tired?

I enjoy it.

T6:

Interview:

1. You used the sandbox to fulfil the mission. Was it all clear? Any questions? After you used this system, are there anything you don't understand yet or anything confusing you?

Actually, it is not very clear. Because I think I do not know how high I need to build for the mountain or deep for the water.

2. Do you know what you just did? After you used this system, do you know its function or usage? Can you simply describe its main purposes that you have understood?

Yes, I just know I need to build the model following the map.

Purpose: just help us to understand the shape of the earth, how it works and the surrounding environment.

3. When you used this sandbox, how you felt about this sandbox? (Difficult /excited /enjoy /curious /impatient) Did you enjoy? Why?

It is a really big sand box. It is quite tiring to build this sand box. And it is also a little boring. Because the sand is not colorful and when you pile up the sand, the sand will fall down again.

4. Before you started the task/ During the task/ After you accomplished the task, I found you spend more time on interacting with the sand. Why? Because you did not understand how to accomplish the task/you just wanted to verify whether your work is accurate or not, or you were just having fun with it?

5. In task 1, do you think you did well? / your work was good?

It is good. Because I basically follow the map. But the surface of the model is not very smooth.

6. In task 2, do you think you actually improved the work you built in task 1?

No. I just make some improvement for the surface, but I did not make any different for the height and depth of the model.

7. So, if I show you a topographical map now, do you think you could understand it? (Show a difference and ask questions – contour lines, watersheds, color means) Do you need additional information to understand it? What kind of information you need?

Yes, I understand. But I also need additional information to help.

8. During the task, you asked us for help/asked us some questions. Why? Because these questions bothered you to complete the task or you were just interested in these questions?

9. Do you think whether the projection / label can help you better understand a topographical map (the contour lines, watersheds, catchment areas, levees, etc.)? / How would you improve it? (Projection / label)

Yes.

10. Suppose that you want to learn some earth science, do you think the sandbox can facilitate you to better understand and learn these knowledge? Or would you prefer a book, a paper map or something else?

Yes, I can help me to show the 3d model, if it can add some color, it will help me to understand.

Paper map.

11. What did you like or dislike of the sandbox? For example, there was something particularly confusing/irritating?

It is not very interesting. Because like I said, it is quite boring and it is a huge sand box. It is quite tiring to build the model. Take too much time to build the model.

12. Would you like to play the sandbox with your friends? Or you just want to play alone? Why? (Social experience)

I like to play with my friends. Because we will make it quick and share some ideas about building models.

13. After the task, how do you feel? Do you feel maybe a little tired?

No very excited. It is a little tiring.

T7:

1. You used the sandbox to fulfil the mission. Was it all clear? Any questions? After you used this system, are there anything you don't understand yet or anything confusing

you?

YES, I know where is high and where is low, but I do not know how exactly the red represents

2. Do you know what you just did? After you used this system, do you know its function or usage? Can you simply describe its main purposes that you have understood?

YES, use different color to present different altitude

3. When you used this sandbox, how you felt about this sandbox? (difficult /excited /enjoy /curious /impatient) Did you enjoy? Why?

It is very interesting. Yes, because I have not played with this kind of thing before.

4. Before you started the task/ During the task/ After you accomplished the task, I found you spend more time on interacting with the sand. Why? Because you did not understand how to accomplish the task/you just wanted to verify whether your work is accurate or not, or you were just having fun with it?

I just want to make it plain, maybe easier for me to complete the task.

I just want to have fun with it.

5. In task 1, do you think you did well? / your work was good?

No, because it does not appear the same as the picture shows.

The red color in this sandbox is not red enough as the picture.

6. In task 2, do you think you actually improved the work you built in task 1?

I am not sure. I just want to make a larger lake. I like larger lake.

7. So, if I show you a topographical map now, do you think you could understand it? (Show a difference and ask questions – contour lines, watersheds, color means) Do you need additional information to understand it? What kind of information you need?

Yes. Different colors means the different heights.

The lines are the counter lines.

8. During the task, you asked us for help/asked us some questions. Why? Because these questions bothered you to complete the task or you were just interested in these questions?

I think the sand is not enough, I need more to complete the task.

9. Do you think whether the projection / label can help you better understand a topographical map (the contour lines, watersheds, catchment areas, levees, etc.)? / How would you improve it? (Projection / label)

Yes, the different colors change helps me better understand it.

10. Suppose that you want to learn some earth science, do you think the sandbox can

facilitate you to better understand and learn these knowledge?

Or would you prefer a book, a paper map or something else?

Yes, the real sand with sandbox is more helpful, because I can touch the height

11. What did you like or dislike of the sandbox? For example, there was something particularly confusing/irritating?

Yes, I like it, it is very interesting

I dislike: When I create the map, the different heights, I want to make this space redder, but it failed.

12. Would you like to play the sandbox with your friends? Or you just want to play alone? Why? (Social experience)just play alone, because I want to explore more

Play alone. I think I can finish it by myself, without other people.

13. After the task, how do you feel? Do you feel maybe a little tired?

I want to play it again.

It is very interesting and I can learn more about geography.

T8:

1. You used the sandbox to fulfil the mission. Was it all clear? Any questions? After you used this system, are there anything you don't understand yet or anything confusing you?

I think it is clear and easy to use it.

2. Do you know what you just did? After you used this system, do you know its function or usage? Can you simply describe its main purposes that you have understood?

To use sand to some river and land, It just replicate the map

It's easier to understand a map than just see the picture

3. When you used this sandbox, how you felt about this sandbox? (difficult /excited /enjoy /curious /impatient) Did you enjoy? Why?

It's interesting and I enjoy it, but after I played the first time, I want to try second, but if you ask me to try the third time, maybe I am not interested.

4. Before you started the task/ During the task/ After you accomplished the task, I found you spend more time on interacting with the sand. Why? Because you did not understand how to accomplish the task/you just wanted to verify whether your work is

accurate or not, or you were just having fun with it?

I just want to know how to use it and because you didn't say anything how to use it. So I want to try this one. After I know how to use it, it's really easy.

5. In task 1, do you think you did well? / your work was good?

Yes, I spends more time to keep this map perfect and as same as the map.

6. In task 2, do you think you actually improved the work you built in task 1?

Yeah. (I delate the house) because I prefer to live somewhere nearby the river and land, but it's nearby the highland. I want to see the mountains and rivers.

7. So, if I show you a topographical map now, do you think you could understand it? (Show a difference and ask questions – contour lines, watersheds, color means) Do you need additional information to understand it? What kind of information you need?

Yeah, the red one means the high, the blue one means the low.

Yes, the lines mean different high levels.

8. During the task, you asked us for help/asked us some questions. Why? Because these questions bothered you to complete the task or you were just interested in these questions?

I add some sand to this place but it does not change colors.

9. Do you think whether the projection / label can help you better understand a topographical map (the contour lines, watersheds, catchment areas, levees, etc.)? / How would you improve it? (Projection / label)

Yeah, it's useful.

10. Suppose that you want to learn some earth science, do you think the sandbox can facilitate you to better understand and learn these knowledge? Or would you prefer a book, a paper map or something else?

I think it's useful. Because I can use real sands to form different lands, such as rivers and mountains, I think it's more interesting and useful.

Actually I prefer to choose this 3d map with projection.

(Why)Interesting

11. What did you like or dislike of the sandbox? For example, there was something particularly confusing/irritating?

I think it's cool but if no sand in my nails, I feel better.

12. Would you like to play the sandbox with your friends? Or you just want to play alone? Why? (Social experience)

Actually I think both, I think it has different funs.

13. After the task, how do you feel? Do you feel maybe a little tired?

I think I am excited to do this.

T9:

1. You used the sandbox to fulfil the mission. Was it all clear? Any questions?

After you used this system, are there anything you don't understand yet or anything confusing you?

I think it's all clear.

2. Do you know what you just did? After you used this system, do you know its function or usage? Can you simply describe its main purposes that you have understood?

Like making a map using sand, examing by the Kinect device and showed on your computers.

3. When you used this sandbox, how you felt about this sandbox? (difficult /excited /enjoy /curious /impatient) Did you enjoy? Why?

Quite interesting, and listen in a video way to show geography mission.

4. Before you started the task/ During the task/ After you accomplished the task, I found you spend more time on interacting with the sand. Why? Because you did not understand how to accomplish the task/you just wanted to verify whether your work is accurate or not, or you were just having fun with it?

5. In task 1, do you think you did well? / your work was good?

Yes, I think so.

6. In task 2, do you think you actually improved the work you built in task 1?

Yes, maybe more interesting.

7. So, if I show you a topographical map now, do you think you could understand it? (Show a difference and ask questions – contour lines, watersheds, color means) Do you need additional information to understand it? What kind of information you need?

This one looks like mountainous areas which be height differences is quite significant, and you got two peaks and one abyss.

Me: Do you know the lines mean?

Yes.

8. During the task, you asked us for help/asked us some questions. Why? Because these

questions bothered you to complete the task or you were just interested in these questions?

9. Do you think whether the projection / label can help you better understand a topographical map (the contour lines, watersheds, catchment areas, levees, etc.)? / How would you improve it? (Projection / label)

Yes, I think so.

10. Suppose that you want to learn some earth science, do you think the sandbox can facilitate you to better understand and learn these knowledge?

Yes, I think so.

Or would you prefer a book, a paper map or something else?

I think not purely, because this map is quite useful but if you really want a missions that, the books or some other additional reference source will be much more helpful than the pure map.

11. What did you like or dislike of the sandbox? For example, there was something particularly confusing/irritating?

First, that is an interactive map, and the response time is quite satisfactory. It`s almost like immediate response to my actions to maps.

I think the point need to be improved is that we can have more animated elements corresponding to the gestures, for example, if I tap somewhere on the map and it can show me the detailed information of the actual height of the point I tapped.

12. Would you like to play the sandbox with your friends? Or you just want to play alone? Why? (Social experience)

I prefer to play it with my friends.

Because play alone is less fun. Playing with friends, you know, it is an interactive map so we can talk and share ideas about the map, sort like that.

13. After the task, how do you feel? Do you feel maybe a little tired?

Tired or excited? I think I can say in mid.

T10:

1. You used the sandbox to fulfil the mission. Was it all clear? Any questions? After you used this system, are there anything you don't understand yet or anything confusing you?

Nope, everything seemed good.

2. Do you know what you just did? After you used this system, do you know its function or usage? Can you simply describe its main purposes that you have understood?

Yeah, just follow the instruction, use sand to make different topographies, like rivers， mountains with different hight, put label on them, marked them as house or something.

3. When you used this sandbox, how you felt about this sandbox? (difficult /excited /enjoy /curious /impatient) Did you enjoy? Why?

Actually I felt a little bit confused. Because the map is so large, when I put a label on this place, next time I cannot make comparison with it to determine the hight.

4. Before you started the task/ During the task/ After you accomplished the task, I found you spend more time on interacting with the sand. Why? Because you did not understand how to accomplish the task/you just wanted to verify whether your work is accurate or not, or you were just having fun with it?

5. In task 1, do you think you did well? / your work was good?

I don't think so

6. In task 2, do you think you actually improved the work you built in task 1?

Especially in task 2, just like I said before it is hard to make comparison between each subject.

7. So, if I show you a topographical map now, do you think you could understand it? (Show a difference and ask questions – contour lines, watersheds, color means) Do you need additional information to understand it? What kind of information you need?

Yes, I can understand this map, it shows the different hight. The red one is the highest one and blue one is the lowest. The round means they are in same hight.

8. During the task, you asked us for help/asked us some questions. Why? Because these questions bothered you to complete the task or you were just interested in these questions?

9. Do you think whether the projection / label can help you better understand a topographical map (the contour lines, watersheds, catchment areas, levees, etc.)? / How would you improve it? (Projection / label)

Yes, the label helps.

10. Suppose that you want to learn some earth science, do you think the sandbox can facilitate you to better understand and learn these knowledge? Or would you prefer a book, a paper map or something else?

I think I may prefer the paper maps, the sandbox is too large and not convenient and it is not clear to show the useful information.

11. What did you like or dislike of the sandbox? For example, there was something

particularly confusing/irritating?

I like it, it is interactive and user friendly, but the disadvantages is that i can get clear information from each objects.

12. Would you like to play the sandbox with your friends? Or you just want to play alone? Why? (Social experience)

Defiantly I will play with my friend. Although it is not accurate, it is really enjoyable and good thing for leisure time.

13. After the task, how do you feel? Do you feel maybe a little tired?

Not so tired.

T11:

1. You used the sandbox to fulfil the mission. Was it all clear? Any questions? After you used this system, are there anything you don't understand yet or anything confusing you?

No, it is not clear. I will confuse…about…you know what, when you want to make a lake, you put the sand outside and you don't know where to put them. And if you put the sand just inside of the lake, you'll destroy the whole map. If you want to do a mountain after, you'll mass everything up, because you don't know where to put the sand.

So would you like more sand so you can add?

No, because it couldn't show the geography scale correctly. It's not so clear for me where to put the sand. This is small because there is less sand. It's because I can't get effect feedback from the box.

2. Do you know what you just did? After you used this system, do you know its function or usage?
3. When you used this sandbox, how you felt about this sandbox? (difficult /excited /enjoy /curious /impatient) Did you enjoy? Why?

Yes, it is quite boring, this is just sand. It's like doing homework. It's like the teacher ask you to do a homework.

4. Before you started the task/ During the task/ After you accomplished the task, I found you spend more time on interacting with the sand. Why? Because you did not understand how to accomplish the task/you just wanted to verify whether your work is accurate or not, or you were just having fun with it?
5. In task 1, do you think you did well? / your work was good?

No. Because I felt selling out when I do the next task, so I divided the graph into several parts, and the first one is the lake, I made a lake and when I made the mountain, the mountain just next to the lake, I messed the lake up.

6. In task 2, do you think you actually improved the work you built in task 1?

No.

But do you think your work in task 2 is more beautiful?

Yes.

7. So, if I show you a topographical map now, do you think you could understand it? (Show a difference and ask questions – contour lines, watersheds, color means) Do you need additional information to understand it? What kind of information you need?

So, I know the red color means high, and blue means low, but for the purple, I guess it's lower than blue, but not sure.

The line means on this line, they are at the same height.

8. During the task, you asked us for help/asked us some questions. Why? Because these questions bothered you to complete the task or you were just interested in these questions?
9. Do you think whether the projection / label can help you better understand a topographical map (the contour lines, watersheds, catchment areas, levees, etc.)? / How would you improve it? (Projection /label)

Yes.

I think not all the labels come to use, I think actually the shape of the object could use for that.

I think the house used for the last task is better than the labels.

I wonder about your labels, how to change the labels into the object. I think labels are better for additional description for the landscape, for the shape, and objects are for options, objects are for the houses, the trees to make it more beautiful.

10. Suppose that you want to learn some earth science, do you think the sandbox can facilitate you to better understand and learn these knowledge?

Yes, I think so. If with clear description.

11. What did you like or dislike of the sandbox? For example, there was something particularly confusing/irritating?

I really like, we can actually interact with it, we can make our mountains and lake ourselves, but you don't have washroom.

12. Would you like to play the sandbox with your friends? Or you just want to play alone? Why? (Social experience)

Friends but not too many people. I think up to four.

Because this is very annoyed. I imagine if this sandbox is located in a science museum and there are children all around and playing the sand, and

And it's clear that if we have a target to make or we have…it will be more interesting if we have some example pictures around like the users made this.

13. After the task, how do you feel? Do you feel maybe a little tired?

Yes. Because it's boring. It's boring without AR.

T12:

1. You used the sandbox to fulfil the mission. Was it all clear? Any questions? After you used this system, are there anything you don't understand yet or anything confusing you?

Not much.

Not really.

2. Do you know what you just did? After you used this system, do you know its function or usage?

Making the landscapes, the light we show, the height of what I made.

3. When you used this sandbox, how you felt about this sandbox? (difficult /excited /enjoy /curious /impatient) Did you enjoy? Why?

It's quite fun. Many people like interaction or maybe to add more fun to weekends.

4. Before you started the task/ During the task/ After you accomplished the task, I found you spend more time on interacting with the sand. Why? Because you did not understand how to accomplish the task/you just wanted to verify whether your work is accurate or not, or you were just having fun with it?
5. In task 1, do you think you did well? / your work was good?

I just use my hands I think I did OK.

6. In task 2, do you think you actually improved the work you built in task 1?

I make the water deeper, so yes.

7. So, if I show you a topographical map now, do you think you could understand it? (Show a difference and ask questions – contour lines, watersheds, color means) Do you need additional information to understand it? What kind of information you need?

Roughly, and the like it represents the height, and the number of exact height.

Do you know the lines mean?

Yes, in the border of the number that change and change.

Can you describe this map to me?

These two are mountains, probably lake or the part of the ocean, that's the island.

8. During the task, you asked us for help/asked us some questions. Why? Because these questions bothered you to complete the task or you were just interested in these questions?

I did this maybe need more way to make it easy using the sand.

9. Do you think whether the projection / label can help you better understand a topographical map (the contour lines, watersheds, catchment areas, levees, etc.)? / How would you improve it? (Projection /label)

Yes. Because of just for the sand you'll have just to imagine, the light will let you know what you are making.

10. Suppose that you want to learn some earth science, do you think the sandbox can facilitate you to better understand and learn these knowledge? Or would you prefer a book, a paper map or something else?

If I have time, I think the box is a good idea, but if you don't want to take much time, the paper is the easiest way, this may be a little boring, and less interactive way.

11. What did you like or dislike of the sandbox? For example, there was something particularly confusing/irritating?

It's a big mass in my hand.

12. Would you like to play the sandbox with your friends? Or you just want to play alone? Why? (Social experience)

I'd it alone or maybe just one or two friends, not too many friends.

I think if it is too much people then it will get more confliction and the mission will be dealt with complication, then result.

13. After the task, how do you feel? Do you feel maybe a little tired?

I'll more feel excited about how this can be improved and are used in the study like university and school. Give some teenagers, they will like it to have the interaction when they are studying, I think it will be more interesting to put in education to help.

T13:

1. You used the sandbox to fulfil the mission. Was it all clear? Any questions? After you used this system, are there anything you don't understand yet or anything confusing you?

Actually it's quite clear but when I was doing this kind of thing and I find it really difficult to copy the map exactly especially the contour lines.

2. Do you know what you just did? After you used this system, do you know its function or usage? Can you simply describe its main purposes that you have understood?

What I did is to copy the map that you give me and to modify the whole map.

3. When you used this sandbox, how you felt about this sandbox? (difficult /excited /enjoy /curious /impatient) Did you enjoy? Why?

That's quite interesting and I like to do it again.

4. Before you started the task/ During the task/ After you accomplished the task, I found you spend more time on interacting with the sand. Why? Because you did not understand how to accomplish the task/you just wanted to verify whether your work is accurate or not, or you were just having fun with it?

Because I think it's quite interesting and I have never seen this kind of thing before. So I want to play it more.

I think maybe the technology is really magical because this machine can detect how high the sand is, I have never seen it before.

5. In task 1, do you think you did well? / your work was good?

Yes

6. In task 2, do you think you actually improved the work you built in task 1?

I don't know if I improve the work but I think I change the whole landscape.

7. So, if I show you a topographical map now, do you think you could understand it? (Show a difference and ask questions – contour lines, watersheds, color means) Do you need additional information to understand it? What kind of information you need?

Yes. The red color means the higher place and the second higher place is green and the lowest place is this blue or purple.

The same line means the same height.

8. During the task, you asked us for help/asked us some questions. Why? Because these questions bothered you to complete the task or you were just interested in these questions?

9. Do you think whether the projection / label can help you better understand a topographical map (the contour lines, watersheds, catchment areas, levees, etc.)? / How would you improve it? (Projection / label)

Yes. Because it can tell me immediately how high the sand is and I can know if I did it wrong or right.

10. Suppose that you want to learn some earth science, do you think the sandbox can facilitate you to better understand and learn these knowledge? Or would you prefer a book, a paper map or something else?

Yeah of course.

I think the paper map is better, book is too much. I don't want read them more. Sandbox is best.

11. What did you like or dislike of the sandbox? For example, there was something particularly confusing/irritating?

I just know nothing know about the sandbox，but actually I think maybe it is too big for a kid because I have to go up. And if it will apply in the classroom it will take a lot of space and I don't think classroom can offer every kid to have a sandbox.

12. Would you like to play the sandbox with your friends? Or you just want to play alone? Why? (Social experience)

Both are good. Because sandbox is really funny.

13. After the task, how do you feel? Do you feel maybe a little tired?

Not tired. Actually I want to have more maps and I can copy it and I think it's quite funny.

T14:

Interview:

1. You used the sandbox to fulfil the mission. Was it all clear? Any questions? After you used this system, are there anything you don't understand yet or anything confusing you?

It so funny so you know.

2. Do you know what you just did? After you used this system, do you know its function or usage? Can you simply describe its main purposes that you have understood?

Maybe it was teaching the children the geography and the map.

3. When you used this sandbox, how you felt about this sandbox? (difficult /excited

/enjoy /curious /impatient) Did you enjoy? Why?

If it not expensive and not cost. I think it worth to use for teaching.

It is easy to use, it's very funny. I enjoy it.

4. Before you started the task/ During the task/ After you accomplished the task, I found you spend more time on interacting with the sand. Why? Because you did not understand how to accomplish the task/you just wanted to verify whether your work is accurate or not, or you were just having fun with it?

Just have fun. Because it is so beautiful and magic.

5. In task 1, do you think you did well? / your work was good?

Yeah. Perfect. Absolutely like it.

6. In task 2, do you think you actually improved the work you built in task 1?

Not really. Because it's not suitable for living.

7. So, if I show you a topographical map now, do you think you could understand it? (Show a difference and ask questions – contour lines, watersheds, color means) Do you need additional information to understand it? What kind of information you need?

Yeah. I think the deep sea, the high mountain.

The lines present different heights.

8. During the task, you asked us for help/asked us some questions. Why? Because these questions bothered you to complete the task or you were just interested in these questions? (Yellow higher than green?)

When I ask you, I just started the task, so I have some questions and. Because the yellow and the light green don't have much difference. So I have just ask the question to confirm.

9. Do you think whether the projection / label can help you better understand a topographical map (the contour lines, watersheds, catchment areas, levees, etc.)? / How would you improve it? (Projection / label)

Yeah

10. Suppose that you want to learn some earth science, do you think the sandbox can facilitate you to better understand and learn these knowledge? Or would you prefer a book, a paper map or something else?

Yeah. I think the most impressing me is it can offer me a deep impression about the height. It depends, for example, I think paper is more in high efficiency, but this one maybe cost time, but I think it can give me deep impression, I will remember it after a long time.

11. What did you like or dislike of the sandbox? For example, there was something particularly confusing/irritating?

I like it. Appearance and the reaction, the dynamic.

And it's not confusing me but I think the sandbox just can teach me the one knowledge. Just one knowledge but no other geography. I think we need to trade off between the cost and benefit.

12. Would you like to play the sandbox with your friends? Or you just want to play alone? Why? (Social experience)

With friends. It was funnier and because I am stupid really.

13. After the task, how do you feel? Do you feel maybe a little tired?

I feel …It makes me happy.

T15:

1. You used the sandbox to fulfil the mission. Was it all clear? Any questions? After you used this system, are there anything you don't understand yet or anything confusing you?

It was quite clear.

2. Do you know what you just did? After you used this system, do you know its function or usage? Can you simply describe its main purposes that you have understood?

I thought it was a game, then I can create a different geography. It's like a different types of geography.

3. When you used this sandbox, how you felt about this sandbox? (difficult /excited /enjoy /curious /impatient) Did you enjoy? Why?

It's pretty fun and when I play it, I can be totally focused.

4. Before you started the task/ During the task/ After you accomplished the task, I found you spend more time on interacting with the sand. Why? Because you did not understand how to accomplish the task/you just wanted to verify whether your work is accurate or not, or you were just having fun with it?

5. In task 1, do you think you did well? / your work was good?

I think I did, pretty well. Actually draw out the contour lines.

6. In task 2, do you think you actually improved the work you built in task 1?

I would not say it improve the map, there is no better, it's just another geographical map with some lakes and river. But it actually very feed my imagination about the lake, beautiful neighbourhood I guess, I guess it's like when I did the map, I think it add my subjective consciousness but I have part of the environment, that's why I can improve it to make lake and more suitable for human to live.

7. So, if I show you a topographical map now, do you think you could understand it? (Show a difference and ask questions – contour lines, watersheds, color means) Do you need additional information to understand it? What kind of information you need?

Yes，yes I can understand it.

I'm not sure about the color but when I read this map I usually looking for the numbers.

This is the highest point so that means it must be the mountain top. And that one should be the lowest. So it should be like undersea or something.

8. During the task, you asked us for help/asked us some questions. Why? Because these questions bothered you to complete the task or you were just interested in these questions?
9. Do you think whether the projection / label can help you better understand a topographical map (the contour lines, watersheds, catchment areas, levees, etc.)? / How would you improve it? (Projection / label)

I think if there are measurement or centimetres on the labels, it will be much more helpful.

Because you give me the two maps, the one is numbers on it, the other one is just map, if the labels have the numbers on it, the measurements, and I can be more processed about the heights of the mountains and the lake. I can match the map better. Now I can actually imagine that, but if you give me measurements to measure the heights, I can actually measure it. (the ruler)

10. Suppose that you want to learn some earth science, do you think the sandbox can facilitate you to better understand and learn these knowledge? Or would you prefer a book, a paper map or something else?

Yes. Very helpful.

Of course I need the paper map. I am not learning knowledge and I am just playing.

11. What did you like or dislike of the sandbox? For example, there was something particularly confusing/irritating?

Like: touch of sands

Dislike: for sandbox, just sand is boring, I think it depends on tasks, if I just be asked to play with sandbox, that must be very boring.

12. Would you like to play the sandbox with your friends? Or you just want to play alone? Why? (Social experience)

Both I guess. Because you can enjoy differences.

If it has a task that I must finish, maybe alone is better, because I can really focus.

But if there are no tasks and just funny games like to build something you like, I think playing with friends is better.

13. After the task, how do you feel? Do you feel maybe a little tired?

I don’t feel tired. I feel more calm down and peaceful.

T16:

1. You used the sandbox to fulfil the mission. Was it all clear? Any questions? After you used this system, are there anything you don't understand yet or anything confusing you?

No

2. Do you know what you just did? After you used this system, do you know its function or usage? Can you simply describe its main purposes that you have understood?

Try to use a picture to make a topographic map

3. When you used this sandbox, how you felt about this sandbox? (difficult /excited /enjoy /curious /impatient) Did you enjoy? Why?

It is a little difficult to use it without marking or labels. Maybe it will lead to less accuracy.

Interesting

4. Before you started the task/ During the task/ After you accomplished the task, I found you spend more time on interacting with the sand. Why? Because you did not understand how to accomplish the task/you just wanted to verify whether your work is accurate or not, or you were just having fun with it?

5. In task 1, do you think you did well? / your work was good?

Yes, in some degree

6. In task 2, do you think you actually improved the work you built in task 1?

I didn’t improve it. Because I do not idea how to change and where need to be changed.

7. So, if I show you a topographical map now, do you think you could understand it? (Show a difference and ask questions – contour lines, watersheds, color means) Do you need additional information to understand it? What kind of information you need?

Yes. The color shows the altitude and the lines represent the same height. It is from previous knowledge.

The extra information like paper or picture can do little help for me to understand knowledge in a short time. Maybe the 3D model can help.

8. During the task, you asked us for help/asked us some questions. Why? Because these questions bothered you to complete the task or you were just interested in these questions?

9. Do you think whether the projection / label can help you better understand a topographical map (the contour lines, watersheds, catchment areas, levees, etc.)? / How would you improve it? (Projection / label)

Yes. It give you a visual thing. You can see what you do.

10. Suppose that you want to learn some earth science, do you think the sandbox can facilitate you to better understand and learn these knowledge? Or would you prefer a book, a paper map or something else?

Yes, sandbox is more helpful. It can provide a visual help which is more helpful for understanding the topographical knowledge than imagining it by words

11. What did you like or dislike of the sandbox? For example, there was something particularly confusing/irritating?

The sand in sandbox is too dry which cannot be shaped easily.

12. Would you like to play the sandbox with your friends? Or you just want to play alone? Why? (Social experience)

With friends will be more interesting and funny. We can discuss how to build the sandbox.

13. After the task, how do you feel? Do you feel maybe a little tired?

No, I am not tired. It is an interesting experience and a good way to let students know geography knowledge.

T17:

1. You used the sandbox to fulfil the mission. Was it all clear? Any questions? After you used this system, are there anything you don't understand yet or anything confusing you?

Yes, it is clear and no questions.

2. Do you know what you just did? After you used this system, do you know its function or usage? Can you simply describe its main purposes that you have understood?

Yes, I understand. The first task I need to put some parts high and some parts low and I let some……into fluid……unclear.

3. When you used this sandbox, how you felt about this sandbox? (difficult /excited /enjoy /curious /impatient) Did you enjoy? Why?

I thought this so surprised and amazing, and that it was fine, for fun, and after that I think I know a lot of lecture more about AR.

Actually you did not use AR, so need to

Try to understand how it worked and how it willed with AR.

4. Before you started the task/ During the task/ After you accomplished the task, I found you spend more time on interactin with the sand. Why? Because you did not understand how to accomplish the task/you just wanted to verify whether your work is accurate or not, or you were just having fun with it?

5. In task 1, do you think you did well? / your work was good?

I think so.

6. In task 2, do you think you actually improved the work you built in task 1?

I think I just moved it plan... and moved it...how to say...moved it clear, not to move it more exact.

7. So, if I show you a topographical map now, do you think you could understand it? (Show a difference and ask questions – contour lines, watersheds, color means) Do you need additional information to understand it? What kind of information you need?

Yes. So the purple point is deeper than the light blue and then the point with a tan, and yellow this is higher.

8. During the task, you asked us for help/asked us some questions. Why? Because these questions bothered you to complete the task or you were just interested in these questions?

If you want to know this map, do you need additional information to do that?

Yes I think so, the color curves, imaginary sectors.

9. Do you think whether the projection / label can help you better understand a topographical map (the contour lines, watersheds, catchment areas, levees, etc.)? / How would you improve it? (Projection / label)

Because...I felt the labels like...the labels are island and mountain the high place will tell you which covers the sand for which area, so it helps to understand.

10. Suppose that you want to learn some earth science, do you think the sandbox can facilitate you to better understand and learn these knowledge? Or would you prefer a book, a paper map or something else?

Yes.

I think I first I would like to choose a book or a paper, my book or my things to learn the knowledge and learn how to use the sandbox and then on I would love to play with the sandbox to earn more and would fun

11. What did you like or dislike of the sandbox? For example, there was something particularly confusing/irritating?

The point I like the sandbox is...I think I have made the 2D map into 3D map, it is by myself,

so it's an experience.

12. Would you like to play the sandbox with your friends? Or you just want to play alone? Why? (Social experience)

I think it's better to play with my friends. Because more people, more merriment.

13. After the task, how do you feel? Do you feel maybe a little tired?

Because I felt it's easy to experiment and it's not very big so I don't need to move around.

T18:

1. You used the sandbox to fulfil the mission. Was it all clear? Any questions? After you used this system, are there anything you don't understand yet or anything confusing you?

Few questions to begin with, like first thing was to work out which colour was higher, which one was lower, how much take…for the implementation

2. Do you know what you just did? After you used this system, do you know its function or usage?

Created the landscape.

Can you simply describe the map you have built?

Describe the map?

It is a landscape quite …… and largely…… small lakes and give it you mountains maybe for 4 peaks when the dam is more rich I guess, not so many valleys I guess over the land perhaps the living the whole valley.

3. When you used this sandbox, how you felt about this sandbox? (difficult /excited /enjoy /curious /impatient) Did you enjoy? Why?
4. Before you started the task/ During the task/ After you accomplished the task, I found you spend more time on interacting with the sand. Why? Because you did not understand how to accomplish the task/you just wanted to verify whether your work is accurate or not, or you were just having fun with it?
5. In task 1, do you think you did well? / your work was good?

Not really. I can give still quite off, target maps.

6. In task 2, do you think you actually improved the work you built in task 1?

It is a very subjective, I guess.

I have to see a real life manifestation, to see if it was any good, like it might be that the island XXX some view for example, so hard to tell…that house probably ruins natural landscape

7. So, if I show you a topographical map now, do you think you could understand it? (Show a difference and ask questions – contour lines, watersheds, color means) Do you need additional information to understand it? What kind of information you need?

Oh yes.

So I'm guessing the blue/purple related to the sea is under lake. The numbers of the sea level……is high up lake.

It seem to the one……

Do you know different colors can represent the different height?

Yes.

Do you know what the red color mean?

I did, higher point…he is wondering if there is any link vegetation, with which kind of vegetation there is at different heights, if there are pines at higher levels and so on

Do you know the lines meaning?

Same areas (with same high) have same contour line

8. During the task, you asked us for help/asked us some questions. Why? Because these questions bothered you to complete the task or you were just interested in these questions?

9. Do you think whether the projection / label can help you better understand a topographical map (the contour lines, watersheds, catchment areas, levees, etc.)? / How would you improve it? (Projection /label)

I guess, it is hard to say completely because the projection takes a while to update so I could be not able to access immediately if it is correct. Perhaps it help for local comparison

10. Suppose that you want to learn some earth science, do you think the sandbox can facilitate you to better understand and learn these knowledge?

No for me, if you can visualise, you do not need the visual aid so much.

So you would prefer a book, a paper map to know with the knowledge?

I think, online maps

11. What did you like or dislike of the sandbox? For example, there was something particularly confusing/irritating?

I like the fact that is interactive, that has a big era, but I recon in the long time there are not many features so I would rather deal with things like changing numbers. Have high level of dexterity (I think he means he would like an online map where for example he can change

values to manually modify the map)

12. Would you like to play the sandbox with your friends? Or you just want to play alone? Why? (Social experience)

I guess with friends would be more fun but at the same time I would not be able to do it alone if everyone else is busy at the time

13. After the task, how do you feel? Do you feel maybe a little tired?

It is a different experience…my hands got tired.

T19:

1. You used the sandbox to fulfil the mission. Was it all clear? Any questions? After you used this system, are there anything you don't understand yet or anything confusing you?

Oh, Yes.

A map.

2. Do you know what you just did? After you used this system, do you know its function or usage? Can you simply describe its main purposes that you have understood?
3. When you used this sandbox, how you felt about this sandbox? (difficult /excited /enjoy /curious /impatient) Did you enjoy? Why?

I think it's very easy to deploy but I need time to think about how to accomplish the task.

4. Before you started the task/ During the task/ After you accomplished the task, I found you spend more time on interacting with the sand. Why? Because you did not understand how to accomplish the task/you just wanted to verify whether your work is accurate or not, or you were just having fun with it?
5. In task 1, do you think you did well? / your work was good?

Yes.

6. In task 2, do you think you actually improved the work you built in task 1?

Yes. Because I think it's more beautiful.

7. So, if I show you a topographical map now, do you think you could understand it? (Show a difference and ask questions – contour lines, watersheds, color means) Do you need additional information to understand it? What kind of information you need?

The blue one is the sea, and the deeper color is taller than the mountain.

Do you know the lines mean?

It's long. It's hard to describe it. It's just the same height.

And during the task, you asked me about why the blue color can become deeper. Because these questions bother you to accomplish the task or you were just having fun with it, just interesting in these questions?

I think I...I think it's a...it's a confusion. I don't know how to make the tallest...the white ones, so I think the deeper blue one maybe...it's also a question.

8. During the task, you asked us for help/asked us some questions. Why? Because these questions bothered you to complete the task or you were just interested in these questions?
9. Do you think whether the projection / label can help you better understand a topographical map (the contour lines, watersheds, catchment areas, levees, etc.)? / How would you improve it? (Projection / label)

I think it's more interesting than the knowledge on the book, so it can help children to understand.

If let you to use the projection... colors to complete the task, can you describe how it helps you to complete the task? How would you use this projection to improve the map?

You mean the task 2?

I thought I just want to find how to make this map more beautiful, so I think it's...I want to it more colorful, so...

10. Suppose that you want to learn some earth science, do you think the sandbox can facilitate you to better understand and learn these knowledge?

Yes.

Or would you prefer a book, a paper map or something else?

Get them, of course get them.

11. What did you like or dislike of the sandbox? For example, there was something particularly confusing/irritating?

I think it's very interesting because I can enjoy it. Used to just read a book or something, so...

OK, are there anything confusing you?

A video may be worth used if not a big problem.

What problem?

Like how to make this more suitable for this.

12. Would you like to play the sandbox with your friends? Or you just want to play alone? Why? (Social experience)

I think both of these is OK. I can enjoy it with friends but if I do it alone at home is also very interesting.

13. After the task, how do you feel? Do you feel maybe a little tired?

No, very interesting.

T20:

1. You used the sandbox to fulfil the mission. Was it all clear? Any questions? After you used this system, are there anything you don't understand yet or anything confusing you?

I think it's all programmed.

2. Do you know what you just did? After you used this system, do you know its function or usage? Can you simply describe its main purposes that you have understood?

Yes. Slightly different with my mention.

Can you describe what you did?

OK, because I thought my house should be not in the lake

Actually if you don't have AR projection, if I didn't open the AR, it will be OK

Yes, it's hard to determine what height it is

Because it's not a standard or something you can fill out more patents.

3. When you used this sandbox, how you felt about this sandbox? (difficult /excited /enjoy /curious /impatient) Did you enjoy? Why?

I think It's OK, the sand is flat, but not that fun.

4. Before you started the task/ During the task/ After you accomplished the task, I found you spend more time on interacting with the sand. Why? Because you did not understand how to accomplish the task/you just wanted to verify whether your work is accurate or not, or you were just having fun with it?

5. In task 1, do you think you did well? / your work was good?

I think, acceptable.

6. In task 2, do you think you actually improved the work you built in task 1?

I don't think so. Because hart to imagine what did I do and what to be, so it's hard to say improve.

7. So, if I show you a topographical map now, do you think you could understand it?

(Show a difference and ask questions – contour lines, watersheds, color means) Do you need additional information to understand it? What kind of information you need?

Yes.

Can you describe different colors' meaning?

Different color means different height.

And do you know the lines mean?

Yes, it's height line.

So this knowledge is your previous knowledge, right?

Yes.

OK.

8. During the task, you asked us for help/asked us some questions. Why? Because these questions bothered you to complete the task or you were just interested in these questions?
9. Do you think whether the projection / label can help you better understand a topographical map (the contour lines, watersheds, catchment areas, levees, etc.)? / How would you improve it? (Projection / label)

No. Because the size is different, the sand is too big for building mountains. It's hard to describe a detailed geographic map.

10. Suppose that you want to learn some earth science, do you think the sandbox can facilitate you to better understand and learn these knowledge?

If I don't have this knowledge, I think it's slightly helpful.

Or would you prefer a book, a paper map or something else?

It depends if I have to learn all of the knowledge in a short time, I think it's...the book is more effective.

But I think sand is slightly more interesting. And maybe it will help to learn more, but I think the book is better.

11. What did you like or dislike of the sandbox? For example, there was something particularly confusing/irritating?

The sand is clean, I said this before. But this could be bigger and maybe some dress to make it more beautiful.

What does dress mean?

Like small trees and some stone.

12. Would you like to play the sandbox with your friends? Or you just want to play alone? Why? (Social experience)

If it is more interesting, I don't mind play with my friends but as you know it's not that interesting, so both not.

13. After the task, how do you feel? Do you feel maybe a little tired?

No it's not a lot, it's so small sandbox.

T21:

1. You used the sandbox to fulfil the mission. Was it all clear? Any questions? After you used this system, are there anything you don't understand yet or anything confusing you?

Well know.

2. Do you know what you just did? After you used this system, do you know its function or usage? Can you simply describe its main purposes that you have understood?

I made a sandbox graph, and I don't know how to say this.

3. When you used this sandbox, how you felt about this sandbox? (difficult /excited /enjoy /curious /impatient) Did you enjoy? Why?

Quite fine.

Me: But I saw you felt very bored about it.

Actually it's probably more fun, it's…

Me: AR projection?

Yes.

4. Before you started the task/ During the task/ After you accomplished the task, I found you spend more time on interacting with the sand. Why? Because you did not understand how to accomplish the task/you just wanted to verify whether your work is accurate or not, or you were just having fun with it?

5. In task 1, do you think you did well? / your work was good?

I think it should be well.

6. In task 2, do you think you actually improved the work you built in task 1?

Yes.

7. So, if I show you a topographical map now, do you think you could understand it? (Show a difference and ask questions – contour lines, watersheds, color means) Do you need additional information to understand it? What kind of information you need?

Yes.

Me: Can you describe different colors to me?

The dark color means it's very deep, and the red color means it becomes higher. Through colors changing, we can get where the highest and lowest place is, and where the plain is and where the hill is.

Me: Do you know the meaning of these lines?

Contour line?

Me: Yes. Maybe one line the same height.

Yes.

8. During the task, you asked us for help/asked us some questions. Why? Because these questions bothered you to complete the task or you were just interested in these questions?
9. Do you think whether the projection / label can help you better understand a topographical map (the contour lines, watersheds, catchment areas, levees, etc.)? / How would you improve it? (Projection / label)

Yes.

Me: How does the sand help you understand the map?

It shows more direct way to me where is high and where is low. Just this.

Me: It did not show you, you built it, right?

Yes.

Me: So you also think it helped you, do you?

Yes.

10. Suppose that you want to learn some earth science, do you think the sandbox can facilitate you to better understand and learn these knowledge?

Yes.

Me: Or would you prefer a book, a paper map or something else to help you gain the geography knowledge?

Probably.

Me: Which one would you prefer?

Google map. Maybe the 3D google map.

11. What did you like or dislike of the sandbox? For example, there was something particularly confusing/irritating?

You can give me a more specific purpose to build the sandbox. For example, you can build a

lake or a dam, not only just a map.

Me: So you would like another objects or models to add to the map, you think maybe it's more beautiful or active.

Yes

12. Would you like to play the sandbox with your friends? Or you just want to play alone? Why? (Social experience)

Probably. If I get some purpose, for example, just like the chess, I would like to share it with my friends. But only a map, I would like to play it alone.

13. After the task, how do you feel? Do you feel maybe a little tired?

Not really, I feel OK for that.

T22:

1. You used the sandbox to fulfil the mission. Was it all clear? Any questions? After you used this system, are there anything you don't understand yet or anything confusing you?

It's a little bit, not so clear. I can't understand what improvement you want me to achieve. It seems that you want me to change whatever I want to change, but it improved that I can't fully understand it.

2. Do you know what you just did? After you used this system, do you know its function or usage? Can you simply describe its main purposes that you have understood?

Yes, I think I know.

Me: What did you do?

The first one is trying to build up the sandbox that the map you gave to me, and the second one is to change whatever I want to change to build up the symbol from my view.

3. When you used this sandbox, how you felt about this sandbox? (difficult /excited /enjoy /curious /impatient) Did you enjoy? Why?

Interesting. I like it very much. But I think the contour lines and some symbols are not so clear.

4. Before you started the task/ During the task/ After you accomplished the task, I found you spend more time on interacting with the sand. Why? Because you did not understand how to accomplish the task/you just wanted to verify whether your work is accurate or not, or you were just having fun with it?

5. In task 1, do you think you did well? / your work was good?

Not so well. I spend quite a long time to remove the things from the higher place to the deeper one or the lower one. It took me quite a long time, because I could not find whether the deeper one can still go deeper, means it can still be digged deeper or deeper levels. So I think maybe I still need more like clear guide lines of the usage.

6. In task 2, do you think you actually improved the work you built in task 1?

No. I just built what I like to build and what I like it to be, but I don't know if it's built beautiful, but I like it.

7. So, if I show you a topographical map now, do you think you could understand it? (Show a difference and ask questions – contour lines, watersheds, color means) Do you need additional information to understand it? What kind of information you need?

Yes.

Me: Can you describe the meaning of different colours?

The purple one is lower, but still on the ground. The red one is the highest.

Me: Do you know the different lines mean?

The lines mean they are in the same height.

8. During the task, you asked us for help/asked us some questions. Why? Because these questions bothered you to complete the task or you were just interested in these questions?

9. Do you think whether the projection / label can help you better understand a topographical map (the contour lines, watersheds, catchment areas, levees, etc.)? / How would you improve it? (Projection / label)

Me: Do you think whether the projection with different colours can help you understand a topographical map well?

Yes.

Me: How?

I think the color should made to be more, like to introduce more colours inside. I didn't understood all the colors meaning for me.

10. Suppose that you want to learn some earth science, do you think the sandbox can facilitate you to better understand and learn these knowledge?

Yes, definitely.

Or would you prefer a book, a paper map or something else?

I will say if the sandbox can be introduced into the class, it will greatly a good idea. Especially when I was a high school student I found quite difficult to understand the total map. This kind of thing, when it is just introduced to my class, I think it will be more helpful.

So if the student can have the opportunity to try the sandbox, I think it will be quite helpful.

11. What did you like or dislike of the sandbox? For example, there was something particularly confusing/irritating?

I really like this kind of experience, like I have the opportunity to try by myself, I make it, like mountain and something like it. For something I don't like, I would say when I was making the sandbox and if I need to go to further places, my shadow will be put on the sandbox some part of me would be not so clear. When I moved from higher place to lower place, the shadow of myself blocked, I could not find that actually the higher place was already as low as the others, so it made me difficult to understand it.

12. Would you like to play the sandbox with your friends? Or you just want to play alone? Why? (Social experience)

Yes, I do. We can discuss, build it what we want. I think it will be a good experience.

13. After the task, how do you feel? Do you feel maybe a little tired?

Not at all, I quite like it. If you give me more time, I still want to play it with something I like.

T23:

1. You used the sandbox to fulfil the mission. Was it all clear? Any questions? After you used this system, are there anything you don't understand yet or anything confusing you?

I think it's clear enough.

2. Do you know what you just did? After you used this system, do you know its function or usage?

Playing with the sandbox, maybe win knowledge.

3. When you used this sandbox, how you felt about this sandbox? (difficult /excited /enjoy /curious /impatient) Did you enjoy? Why?

I feel relaxed and I want to play it with some water, so I can shape it with more accuracy.

4. Before you started the task/ During the task/ After you accomplished the task, I found you spend more time on interacting with the sand. Why? Because you did not understand how to accomplish the task/you just wanted to verify whether your work is accurate or not, or you were just having fun with it?

5. In task 1, do you think you did well? / your work was good?

I think so.

6. In task 2, do you think you actually improved the work you built in task 1?

Yeah.

7. So, if I show you a topographical map now, do you think you could understand it? (Show a difference and ask questions – contour lines, watersheds, color means) Do you need additional information to understand it? What kind of information you need?

Yes.

Do you know the different colors mean?

The different altitudes.

And do you know the lines mean?

It's of the same altitude, so actually means, it's maybe about two hundred meters high.

8. During the task, you asked us for help/asked us some questions. Why? Because these questions bothered you to complete the task or you were just interested in these questions?

9. Do you think whether the projection / label can help you better understand a topographical map (the contour lines, watersheds, catchment areas, levees, etc.)? / How would you improve it? (Projection /label)

The labels?

Yes, the labels.

Yes.

10. Suppose that you want to learn some earth science, do you think the sandbox can facilitate you to better understand and learn these knowledge?

I think it should help but maybe with children. It is with children has made them feel interesting or something and some to make them feel it's fun. But I think for adults, you can have interesting sandbox as well, but it'll be laggy, you don't have to spend a lot of time on it. Because if for adults, explain it, and like pictures will be better.

So, you think maybe for adult maybe a book or a paper map is better, right?

Yes.

11. What did you like or dislike of the sandbox? For example, there was something particularly confusing/irritating?

I think sand is very easy to shape. But the downside of the sand is troublesome.

So you can play for adults you'll easily, it will be, if people attempt to try to make things perfect, with sand is kind of impossible.

So you mean maybe the wet sand with some water can shape it better?

Yes.

12. Would you like to play the sandbox with your friends? Or you just want to play alone? Why? (Social experience)

I think it will play alone can make things, but if you play with friends you can make things better. I think I don't have prefers but difference that if you play alone you will enjoy, but you can reflect things or you have more using experience, that with you, if you play with friends, it will be a fun time together.

13. After the task, how do you feel? Do you feel maybe a little tired?

I think it's consuming a lot of energy, like physical energy, but I think it's a good thing, I'm feeling a little tired, but physically it is good.

T24:

1. You used the sandbox to fulfil the mission. Was it all clear? Any questions?

No questions

2. Do you know what you just did?

I think I made a topographical map, by using sand projected on it, and show me what it is clear

3. When you used this sandbox, how you felt about this sandbox? (difficult /excited /enjoy /curious /impatient) Did you enjoy? Why?

I like it, it's fun. Yes I did enjoyed it.

4. Before you started the task/ During the task/ After you accomplished the task, I found you spend more time on interacting with the sand. Why? Because you did not understand how to accomplish the task/you just wanted to verify whether your work is accurate or not, or you were just having fun with it?

During the task, because I was having fun with it and I am little bit of a perfectionist so always…

when you show the first map to me it was pretty clear that is blue there and red here, and so those where the key aspects I focused on … everything is that it's not actually orange in the middle, it's actually green, so I try to make it green, so I just take a long time to try dig it. That's actually because I am a professor.

5. In task 1, do you think you did well? / your work was good?

For my personal, complete inability of doing anything, I am usually not the most coordinated person...yes, I think I do

I got so proud of myself.

1. In task 2, do you think you actually improved the work you built in task 1?

Yeah, because I also understand how to make a river, an island and other landscapes.

2. So, if I show you a topographical map now, do you think you could understand it? (Show a difference and ask questions - contour lines, watersheds, color means) Do you need additional information to understand it? What kind of information you need?

Yeah, I think so.

In my head, it's obvious.

I don't know the lines mean. I think the lines are my previous knowledge 15 years ago I study geography.

The lines are closer together, it means a higher altitude, and the separate part means the lower altitude.

Perhaps a little bit additional information, I think I can I feel OK to understand this map, I think I can understand all right.

3. During the task, you asked us for help/asked us some questions. Why? Because these questions bothered you to complete the task or you were just interested in these questions?

4. Do you think whether the projection / label can help you better understand a topographical map (the contour lines, watersheds, catchment areas, levees, etc.)? / How would you improve it? (Projection / label)

I think so, because the projection onto the sand with physical way to show it, it is not just 2D, showing you the blue is lower down, the red is higher, you are physically moving stuff and then the projection shows you, was the physical objects actually means.

The sand is the perfect physical object, because it moves around and projection shows you what it is and what it looks like on 2D map.

5. Suppose that you want to learn some earth science, do you think the sandbox can facilitate you to better understand and learn these knowledge? Or would you prefer a book, a paper map or something else?

Yeah, I think so. It definitely reminds me of the lines, because it has been years I studied this.

It brought back memories of geography class.

Definitely (prefer) the sandbox, I am a physical learner, so reading things always gets stuck, if I actually take something like sand in this case or anything learning I found If I actually to do hands on or trying to build things or creating or walking around, that's much better than reading a book.

6. What did you like or dislike of the sandbox? For example, there was something particularly confusing/irritating?

Like: the colors are really pretty, It is really nice to play with, obviously it is very relaxing to play it and the fact that is responsive, so when you are moving stuff around, you are actually getting a pretty much instant change of projection...I love that, the fact that is responsive.

Dislike: The fact that I have sand under my nails, that's the only negative thing I would say about.

7. Would you like to play the sandbox with your friends? Or you just want to play alone? Why? (Social experience)

Depends on my view. Probably, probably both, probably with friends. Because I have some friends……

I prefer my friends to sit in it and I can build mountains around them.

8. After the task, how do you feel? Do you feel maybe a little tired?

Not at all tired. Actually beneficially I feel better. I was very tired when I came here, but it was so fun, so better and feel relaxed.